Cisco Remote PHY Device Software Configuration Guide for Cisco 1x2 / Compact Shelf RPD Software 5.x

First Published: 2018-07-31

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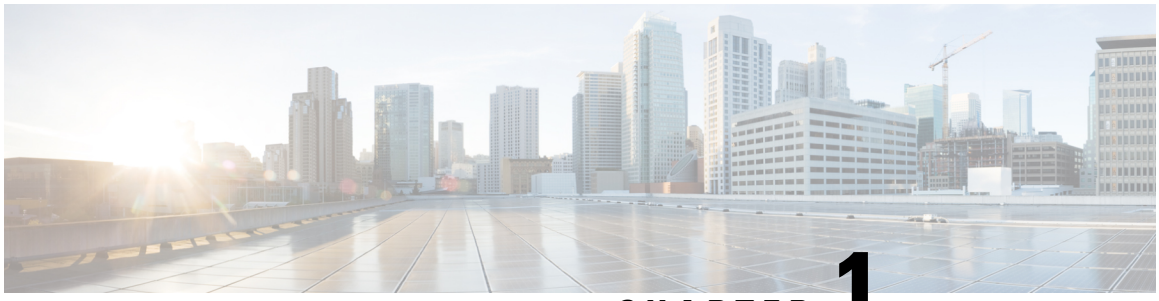
CONTENTS

PART I

Remote PHY System Start Up Configuration



CHAPTER 1

Cisco Remote PHY System Overview

Finding Feature Information

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Introduction

Driven by market evolution towards triple-play services, cable operators in emerging markets are seeking standardized and digital fiber-based solutions for economical and future proof access technologies. Much of the demand is driven by the need to provide higher bandwidth packet transport for Internet connectivity, video and voice services.

Data Over Cable Systems Interface Standard (DOCSIS®) is a standardized technology for services over cable and thus has strong interoperability between system providers. It also provides robust Quality of Service (QoS) methods, ensuring packet delivery during periods of network congestion. Traditionally, DOCSIS runs on linear fiber (or HFC) to provide service and is not naturally applicable for digital fiber. Cisco has bridged the gap by introducing a new access technology called the Remote PHY.

Existing Architecture

In the emerging markets, most triple-play consumers live in multi-tenant buildings (referred to as Multi Dwelling Units or MDU) with the number of residents usually being less than 500 residents per building or cluster. These buildings are typically served by fiber with one of several “final 100 meter” technologies

installed in the buildings. These technologies include fiber, twisted pair, Ethernet, and coaxial. Cable operators have access to the cable in the building and use this cable for their services. Several technologies exist for enabling two-way services over cable. These include a number of proprietary and vendor-specific methods. However, a standards-based approach to using cable is typically preferred by operators, since this ensures vendor interoperability.

Need for the Cisco Remote PHY Solution

DOCSIS and EuroDOCSIS are standards that define two-way operation over a cable network. DOCSIS provides the necessary Quality of Service (QoS) tools for ensuring voice call connectivity during periods of network congestion that are anticipated in triple-play networks. DOCSIS is a robust and mature technology for voice, video, and IP video services.

The Cisco Remote PHY solution leverages existing IP technologies like Ethernet PON (EPON), Gigabit-capable Passive Optical Networks (GPON), and Metro Ethernet (MetroE) equipment; it deploys DOCSIS in MDUs over digital fiber to enable two-way services over cable.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 1: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Benefits

The Cisco Remote PHY solution provides a cost-effective digital fiber-based DOCSIS solution that uses Ethernet PON (EPON), Gigabit-capable Passive Optical Networks (GPON), or Metro Ethernet (MetroE) as the transmission network between the Cisco CMTS and CM. Both the PON technology and DOCSIS is used in the same network.

- Simple and low cost PON transmission as opposed to costly HFC transformation.
- Reduced investment cost including capital and operational expenditure.
- Low-cost yet highly stable Cisco GS7000 node (includes only the PHY layer).
- Reduced CMTS hardware complexity.
- No restriction on Converged Interconnect Network (CIN) network.
- Futureproof architecture. Easy to migrate as the hardware and control functions are on separate layers.
- End-to-end QoS assurance provided by DOCSIS.
- Support for all DOCSIS services.
- Support for existing DOCSIS network provisioning system.
- High access bandwidth.
- With deep fiber, the optical noise contribution to SNR is eliminated. As a result, the remote QAM modulator runs at higher orders of modulation as compared to a centralized QAM modulator.

Cisco CCAP RF Line Card for R-PHY

The Cisco CCAP RF line card for remote PHY architecture is available in two flavours:

- CBR-LC-8D31-16U30—This RF line card with the downstream and upstream PHY modules can be connected with the Cisco GS7000 node by configuring it using the **card cBR-CCAP-LC-40G r-phy** command.
- CBR-CCAP-LC-40G-R—This RF line card with no downstream and upstream PHY modules can be connected with the Cisco GS7000 node.

Cisco Digital Physical Interface Card

The Cisco Digital Physical Interface Card (DPIC) transmits and receives RF signals between the subscriber and headend over the hybrid fiber-coaxial (HFC) system and is DOCSIS-compliant. This interface card is

designed specifically for the Cisco cBR router and conforms to the Integrated CMTS (I-CMTS) architecture. The PID is cBR-DPIC-8X10G.

The DPIC is installed in the CMTS and connected to the Cisco GS7000 node via the EPON, GPON, or Metro Ethernet. It supports both downstream and upstream traffic. Both the downstream and upstream traffic share the same ports.

Table 2: Physical Specifications of the DPIC

Unit	Dimensions
Width	10.96 in (27.8cm)
Height	1.43 in (3.6cm)
Depth	7.32 in (18.6cm) with handle
Weight	2.943lb (1.335kg)

The DPIC supports:

- Eight ten gigabit ethernet SFP+ interfaces
- 80 gigabit non-blocking switching architecture with 40+40 protection scheme
- 40 gigabit DOCSIS traffic bandwidth when connected with the Cisco CBR-CCAP-LC-40G-R line card
- Cisco SFP-10G-SR-S/Cisco SFP-10G-LR-S/Cisco SFP-10G-ZR-S/Cisco SFP-10G-ER-S optic modules
- MACSec and 1588 TC

The faceplate of the Cisco DPIC has the following:

- Optic Cable Clip—Helps route and manage the optic cables.
- 8 x SFP+ ports—Used as 8 x 10GE lanes for DOCSIS traffic to the Cisco RPDs.
- 10GE Link Status LED—Indicates the status of the 10GE link.
- Status LED—Indicates the status of the Cisco DPIC.
- Replace LED—Indicates the Cisco DPIC must be replaced.

Onboard Failure Logging

The Onboard Failure Logging (OBFL) feature enables the storage and collection of critical failure information in the nonvolatile memory of a Field Replaceable Unit (FRU), like a route processor (RP) or line card. The data stored through OBFL assists in understanding and debugging the field failures upon Return Material Authorization (RMA) of a RP or line card at repair and failure analysis sites. OBFL records operating temperatures, voltages, hardware uptime, and any other important events that assist board diagnosis in case of hardware failures.

For more information about the feature, see Onboard Failure Logging.

Note The sample output provided in the Onboard Failure Logging guide may vary slightly for the Cisco CMTS routers.

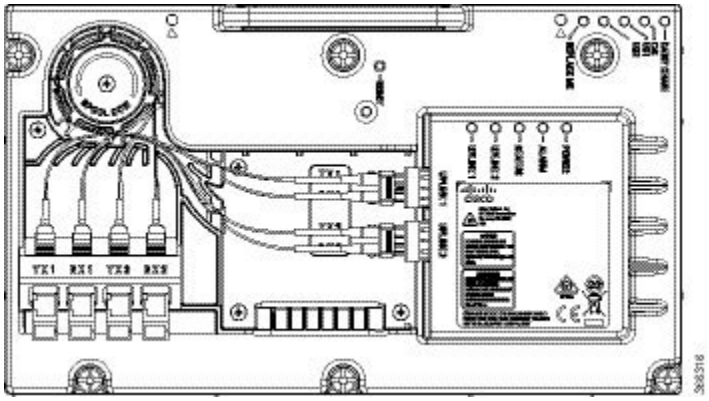
Cisco Remote PHY Device

The Cisco Remote PHY Device (RPD) has two variants – The standard RPD and the newer Intelligent RPD (iRPD). The standard RPD resides inside the Cisco GS7000 node while the Intelligent RPD (iRPD) resides inside the Intelligent Node. Below are some of its features:

- Full spectrum DOCSIS 3.0 support
- Full spectrum DOCSIS 3.1 support
- Converged broadcast, narrowcast, and VOD video support
- Out of Band (OOB) signaling support
- Dual 10GBE SFP/SFP+ backhaul connectivity
- Support of Daisy Chain architecture topology
- CCAP support
- Support of optical overlay architectures

Additionally, the Cisco Intelligent Remote PHY Device (iRPD) provides an interface to the Intelligent Node RF section.This interface supports control plane communication that allows more extensive diagnostic and configuration control. The Intelligent Node supports touch-less configuration, per port spectrum capture, power-savings mode, and other enhanced features.

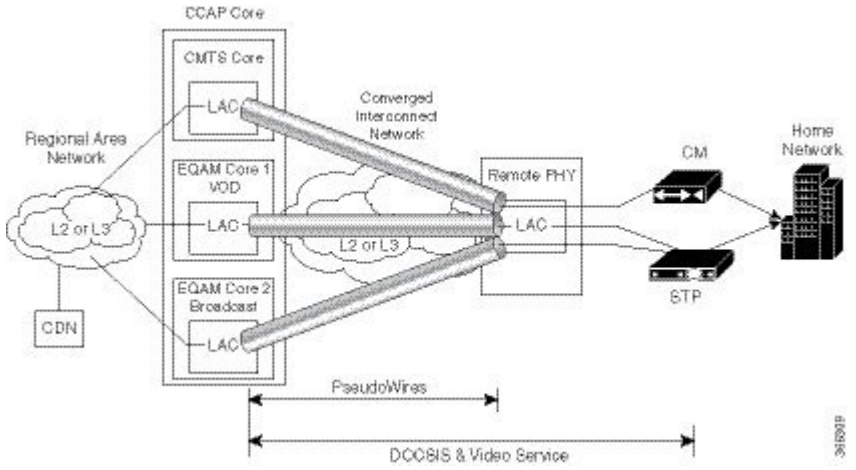
Figure 1: Cisco RPD



Network Architecture

The Cisco Remote PHY solution supports the *Single Controller Sharing* architecture. In this architecture, multiple Cisco GS7000 equipments share the downstream and upstream channels of a Cisco RF line card in a cisco cBR chassis.

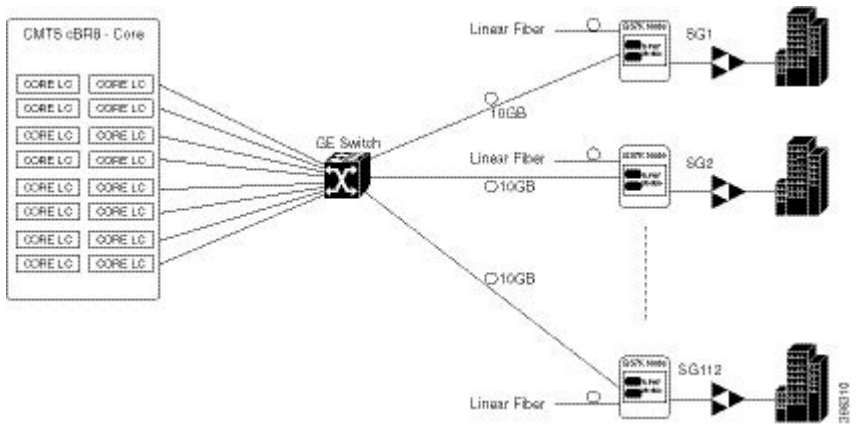
Figure 2: Single Controller Sharing Architecture



Network Topologies

The Cisco Remote PHY solution supports the following Ethernet-based networking topologies.

Figure 3: Standard Deployment



Note If you want to establish Equal-Cost Multi-Path (ECMP) connection between cBR-8 and RPD, pay attention to the ECMP configuration on both cBR-8 and the Converged Interconnect Network (CIN) routers. The number of maximum paths configured must be equal as or larger than the number of ECMP paths you want to set under the routing protocol for cBR-8 and the first adjacent CIN router.

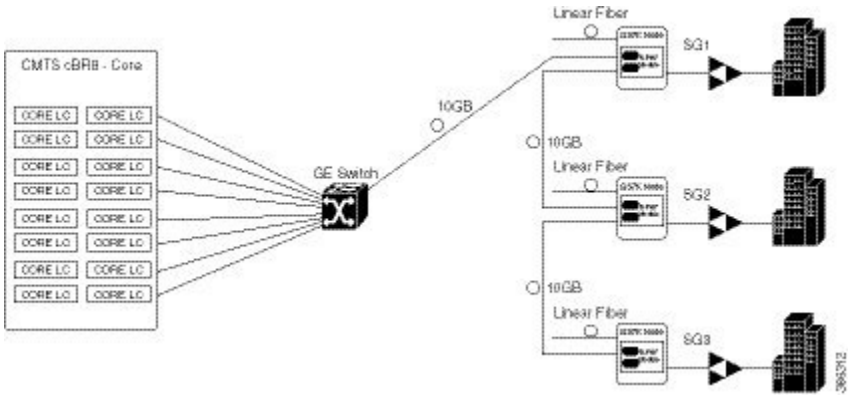
Other Supported Topologies

Figure 4: Path Redundancy Deployment

Daisy Chain Architecture

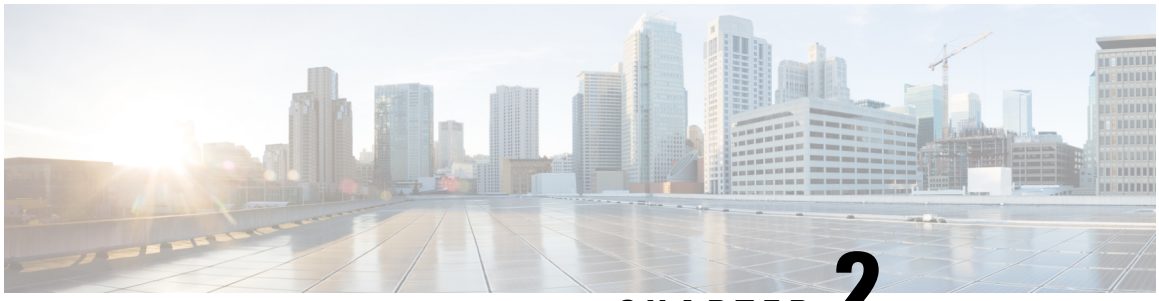
Cisco Remote PHY devices support the daisy chain architecture. The daisy chain architecture includes multiple RPDs connected in series. This daisy chaining topology is transparent to CCAP core. The CCAP core is not notified about the chain topology because before the RPD sets up a GCP connection, notification flow is not configured.

Figure 5: Daisy Chain Deployment



Limitations

- In the daisy-chaining topology, if one RPD in the chain is down or any link in the middle breaks, the RPD in the downstream is disconnected, until the chain is restored again.
- You must be careful when resetting or clearing an RPD, as the CCAP core is not notified about the chain topology. If you clear or reset an upstream RPD in a daisy-chain, all RPDs after that specific RPD will be disconnected until the upstream RPD boots up.
- Each RPD reset needs a reprograming of the FPGA. The connection is interrupted during this reset.
- The daisy-chaining topology uses both 10G ports of an RPD. Hence, features like link redundancy and port redundancy which need a second port are not supported.
- You should ensure that the total upstream traffic from all RPDs in the chain is not oversubscribing the 10G ports.
- The last RPD in the chain is not allowed to connect back to the switch to avoid a ring.
- The maximum number of RPDs in the chain is limited to six.



CHAPTER 2

Cisco Remote PHY System Bring Up

Finding Feature Information

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Hardware Compatibility Matrix for Cisco Remote PHY Device

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Table 3: Hardware Compatibility Matrix for the Cisco Remote PHY Device

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Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information about RPD Bring Up

Remote PHY device bring up process is prerequisite to the operation of the remote PHY system, just like the cable modem bring up in a DOCSIS system.

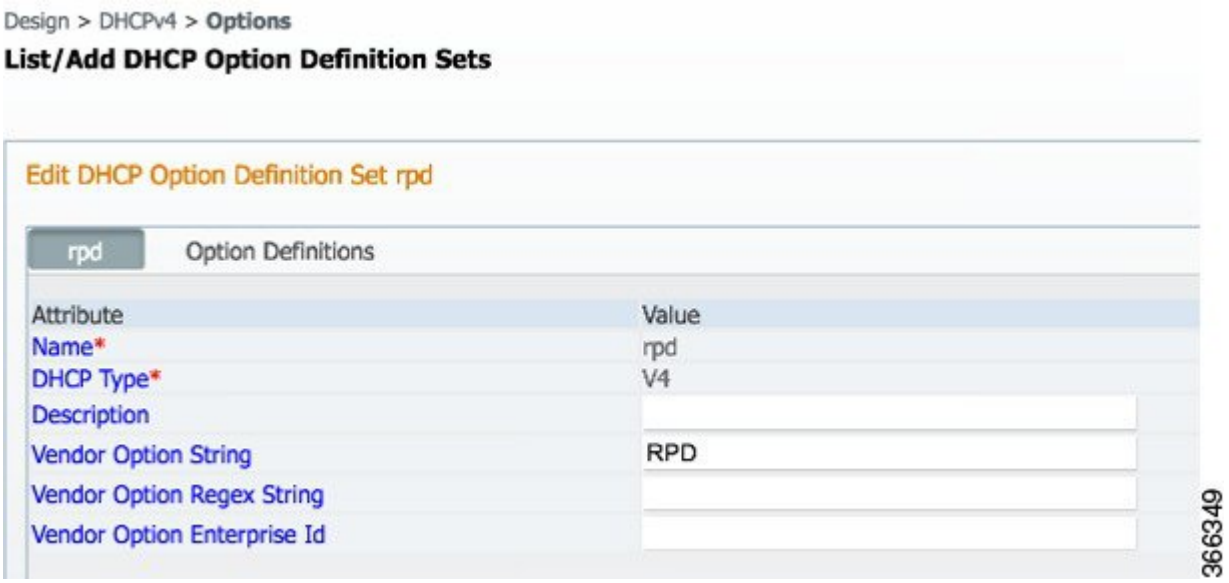
How to Bring Up RPD

This section describes how to bring up RPD on Cisco cBR-8.

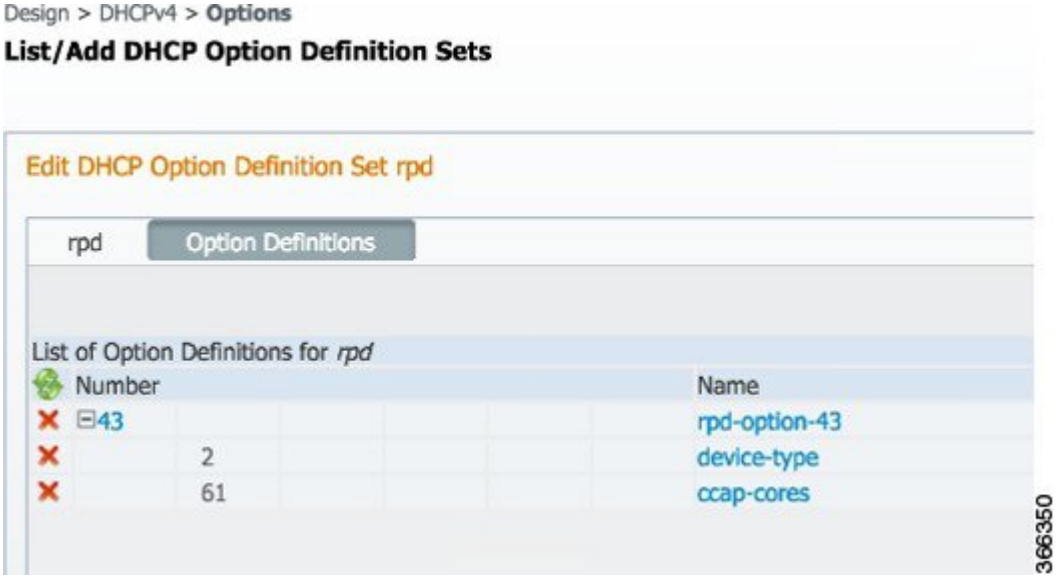
Configuring DHCP Server

To configure DHCP server, follow the steps below:

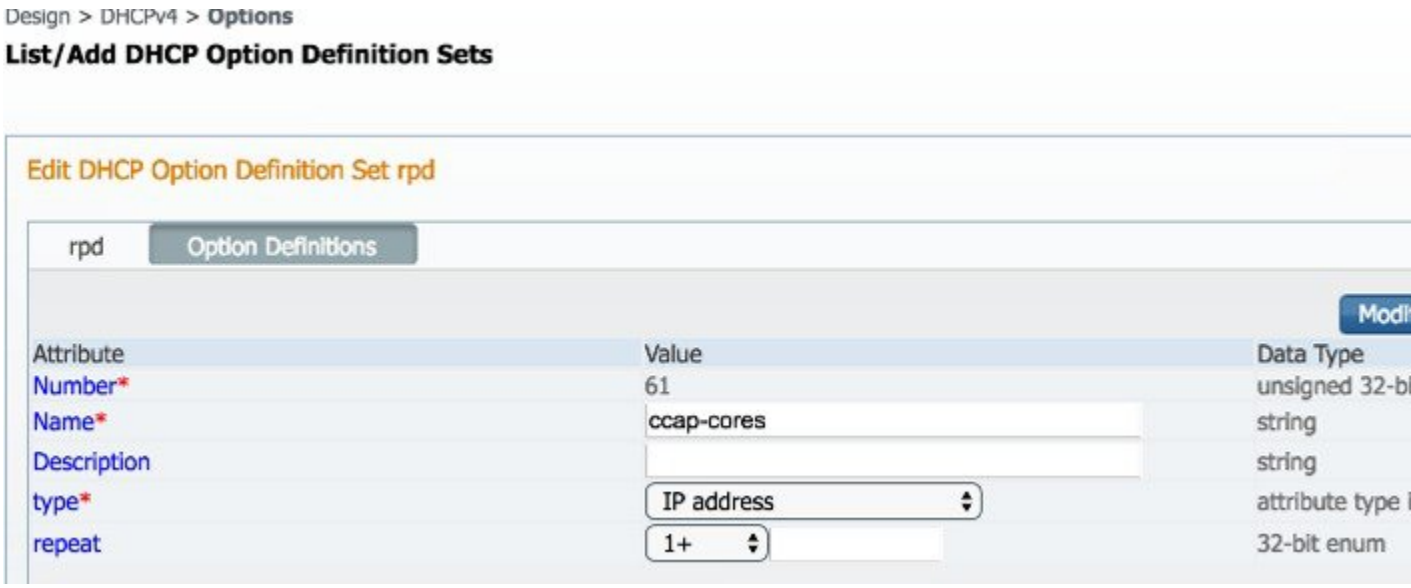
Step 1 Add option for CCAP-Core. Fill in the name, DHCP type, and vendor option string as shown in the figure below.



Step 2 Define option. Fill in the option number and name as shown in the figure below.



Step 3 Define suboption. Fill in the name, type and repeat of suboption 61 as shown in the figure below..



Step 4 Add the option into policy as shown in the figure below. Replace the IP address 120.102.15.1 in the figure to the DPIC port IP address.

Configuring PTP

To configure PTP, use the following example as reference:

On cBR-8 router:

```
interface Loopback1588
  ip address 159.159.159.4 255.255.255.255
interface TenGigabitEthernet5/1/3   /* connect to ASR903 */
  ip address 192.104.10.4 255.255.255.0

ip route 10.90.3.93 255.255.255.255 192.104.10.93   /* route to ASR903 loopback ip */

ptp clock ordinary domain 0
  servo tracking-type R-DTI
  clock-port slave-from-903 slave
    delay-req interval -4
    sync interval -5
    sync one-step
    transport ipv4 unicast interface Lo1588 negotiation
    clock source 10.90.3.93   /* ASR903 loopback ip */

ptp r-dti 1
```

```
  ptp-domain 0   /* same domain number with ptp server */
  clock-port 1
    ethernet 1   /* default value is same index with clock-port index, for RPD, ethernet
1=vbh0, ethernet 2=vbh1 */
    clock-source 10.90.3.93 gateway 93.3.10.2   /* clock-source is ASR093 loopback ip,
gateway is ASR903 BDI ID for node */
```

On ASR903 router as PTP master:

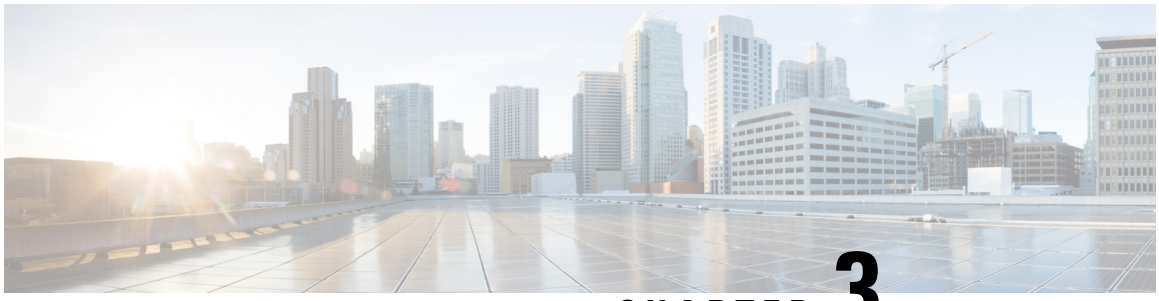
```
ptp clock ordinary domain 0
 clock-port Master-to-all-cBR8 master
  sync interval -5
  sync one-step
  transport ipv4 unicast interface Lo1588 negotiation

interface Loopback1588
 ip address 10.90.3.93 255.255.255.255

interface GigabitEthernet0/3/5
 no ip address
 negotiation auto
 cdp enable
 service instance 31 ethernet   /* 31 is vlan id */
  encapsulation dot1q 31
  rewrite ingress tag pop 1 symmetric
  bridge-domain 31
 service instance 32 ethernet
  encapsulation dot1q 32
  rewrite ingress tag pop 1 symmetric
  bridge-domain 32
interface BDI31   /* for cBR, SUP PIC */
 ip address 192.104.10.93 255.255.255.0
 no shut
interface BDI32   /* For RPD */
 ip address 93.3.10.2 255.255.255.0
 no shut

ip route 159.159.159.4 255.255.255.255 192.104.10.48   /* route to cbr-8 loopback ip */
```

Configuring cBR-8

To configure the cBR-8 to bring up the RPD, use the following example as reference:

```
/* D-PIC TenGiga interface config */
interface TenGigabitEthernet0/1/0
  ip address 93.3.10.1 255.255.255.0
  ip helper-address 20.1.0.33

/* Downstream/Upstream controller profile */
cable downstream controller-profile 101
rf-chan 0 95
  type DOCSIS
  frequency 381000000
  rf-output NORMAL
  qam-profile 1
  docsis-channel-id 1

cable upstream controller 201
  us-channel 0 channel-width 1600000 1600000
  us-channel 0 docsis-mode atdma
  us-channel 0 minislot-size 4
```

```
  us-channel 0 modulation-profile 221
  no us-channel 1 shutdown

/* RPD configuration */
cable rpd node1
  identifier 0004.9f03.0061
  core-interface Te0/1/0
    rpd-ds 0 downstream-cable 0/0/0 profile 101
    rpd-us 0 upstream-cable 0/0/0 profile 201
  r-dti 1
  rpd-event profile 0

interface Cable0/0/0
  load-interval 30
  downstream Downstream-Cable 0/0/0 rf-channel 0-23
  upstream 0 Upstream-Cable 0/0/0 us-channel 0
  upstream 1 Upstream-Cable 0/0/0 us-channel 1
  upstream 2 Upstream-Cable 0/0/0 us-channel 2
  upstream 3 Upstream-Cable 0/0/0 us-channel 3
  cable upstream bonding-group 1
    upstream 0
    upstream 1
    upstream 2
    upstream 3
    attributes 80000001
    cable bundle 1
  cable ip-init ipv6
interface Wideband-Cable0/0/0:0
  cable bundle 1
  cable rf-channels channel-list 0-7 bandwidth-percent 10
interface Wideband-Cable0/0/0:1
  cable bundle 1
  cable rf-channels channel-list 8-15 bandwidth-percent 10
cable fiber-node 200
  downstream Downstream-Cable 0/0/0
  upstream Upstream-Cable 0/0/0
```



CHAPTER 3

Network Authentication

This document describes the Remote PHY device network authentication on the Cisco cBR Series Converged Broadband Router.

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Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information about Network Authentication

RPD must be able to operate in both authenticated and unauthenticated networks. Whether authentication is required for an RPD is determined by the network that it is connected to. In some cases, RPD is located in an untrusted network, and it must connect to devices inside the trusted network, which presents a potential security vulnerability. 802.1x is introduced to provide authentication services to eliminate the potential security issues.

802.1x is a Layer 2 protocol that uses EAP (Extensible Authentication Protocol) to provide authentication services. Following certificates are needed to use the network authentication:

- Cablelabs Root CA certificate: caRoot.pem
- CableLabs Device CA Certificate: deviceCA.pem
- RPD Certificate: rpdCert.pem, private key: rpd.key
- Cablelabs Service Provider CA Certificate: spCA.pem
- AAA Server Certificate: aaaCert.pem, private key: aaa.key

How to Enable Network Authentication

This section describes how to enable network authentication for RPD.

Installing Certificates in Radius Server

To install the certificate in Radius server, follow the steps below:

Step 1 Combine CA certificate for AAA server.

Example:

```
cat spCA.pem caRoot.pem > ca_root_srv.pem
```

Step 2 In freeRadius Server, copy "ca_root_srv.pem", "spCA.pem", "aaaCert.pem" and "aaa.key" to "/etc/freeradius/certs".

Configuring Radius Server

To install the certificate in RPD, follow the steps below:

Step 1 Define a new client in /etc/freeradius/clients.conf.

Example:

```
client rphytest_ng13 {
        ipaddr = 20.5.0.36
        secret = rphytest
        shortname = ng13_switch
        require_message_authenticator = yes
}
```

The "ipaddr" is the switch's management ip address.

Step 2 In "/etc/freeradius/eap.conf", change the following lines in "tls" to specify the server's private key file and certificate files.

Example:

```
tls {
      …
        private_key_file = ${certdir}/aaa.key
        certificate_file = ${certdir}/aaaCert.pem
        CA_file = ${cadir}/ca_root_srv.pem
}
```

Step 3 Start radius in radius sever.

Example:

```
sudo freeradius
```

Make sure only one freeradius instance is running.

Configuring Switch

To configure the switch, follow the steps below:

Note This procedure is for Catalyst 3750 switch, other switch may use different commands.

Step 1 Add the following configuration in global configuration mode.

Example:

```
dot1x system-auth-control   /* enable 802.1x */
aaa new-model
aaa authentication dot1x default group radius
radius-server host 10.79.41.103 auth-port 1812 key rphytest
```

Step 2 Add the following configuration under interface which connects to RPD.

Example:

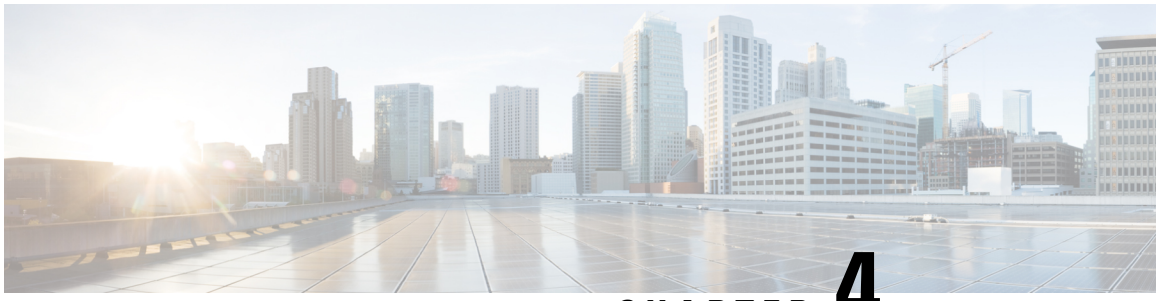
```
authentication port-control auto
dot1x pae authenticator
```

Verifying Authentication Status

To displays dot1x authentication information for RPD, use the **show dot1x** command as shown in the following example:

```
Router# show dot1x summary
 Interface        Core-id                  EAP_Received     Status
 vbh0             CORE-3415960568          True             UP

Router# show dot1x detail
Interface        Core-id                 EAP_Received        Status
vbh0             CORE-3415960568         True                UP
bssid=01:80:c2:00:00:03
freq=0
ssid=
id=0
mode=station
pairwise_cipher=NONE
group_cipher=NONE
key_mgmt=IEEE 802.1X (no WPA)
wpa_state=COMPLETED
ip_address=30.85.40.47
address=00:04:9f:00:03:73
Supplicant PAE state=AUTHENTICATED
suppPortStatus=Authorized
EAP state=SUCCESSselected
Method=13 (EAP-TLS)EAP TLS
cipher=ECDHE-RSA-AES256-SHA
tls_session_reused=0
eap_session_id=0d53798f5b46014cc92a4ac1151521bae6a14c98f919eb5e8c81a701b7272be7f812e7e5a75881768d74d311795a3b1f0e37bfa7fff7dcc4685d36f216bec59850
uuid=ab722cfb-84dc-5835-a905-edfec20f78c3
```



CHAPTER 4

Synchronizing Time on Cisco Remote PHY Devices

This section explains how to synchronize time on the Remote PHY (R-PHY) devices and CCAP core of the Cisco cBR Router.

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Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information about Time Synchronization

In a Remote PHY system, synchronizing its local timestamp and reference frequency to the cable converged access platform core function (CCAP Core) is important. The protocol used for this feature, the Precision Time Protocol (PTP), helps in synchronizing time between a CCAP core function and a series of remote PHY devices (RPD) that enable R-PHY and provides support for converged DOCSIS, video, and out-of-band (OOB) services.

Cisco CBR-8 supports PTP Ordinary Clock (OC) slave mode, in which the PTP slave ports are from the backhaul 10GE Ethernet ports or the management Ethernet ports of SUP PIC.

Remote DTI

Remote DOCSIS Timing Interface (R-DTI) is the network synchronization protocol used between CCAP-core and R-PHY. When traffic from the CCAP-Core is received on the downstream receiver, the following processes occur:

- Terminates DEPI framing
- Extracts the payload, frames it, modulates, and transmits it out

During the upstream process, the signal is received from the coax and the system demodulates it. From the FEC payload, the DOCSIS frames are extracted and placed in the UEPI encapsulation. The frames are then transmitted through the upstream transmitter to the CCAP core. A local CPU manages DEPI and GCP control planes, and interfaces with network management. A clocking circuit interfaces with the R-DTI and manages clocking for the R-DTI entity.

The GS7000 R-PHY supports map re-stamp option.

Restrictions for Configuring Time Synchronization

The following restrictions are applicable to configuring time synchronization on Cisco cBR.

- Cisco cBR and RPD does not support PTP over IPv6
- Cisco cBR supports only the PTP slave on SUP-PIC

How to Configure Time Synchronization

Note To know more about the commands referenced in this module, see the Cisco IOS Master Command List.

Configuring Time Interface and PTP domain

To configure time interface and PTP domain, use the following procedure.

```
enable
configure terminal
interface type [slot_#/]port_#
interface Loopback1588
  ip address <IP Address/subnet>

interface TenGigabitEthernet<slot/port>
  ip address <IP Address/subnet>

ip route < PTP master IP Address/subnet> < loopback IP Address>

ptp clock ordinary domain 0 (This is for CBR PTP connection)
 servo tracking-type R-DTI
 clock-port slave-from-903 slave
  delay-req interval -4
  sync interval -5
  sync one-step
  transport ipv4 unicast interface Lo1588 negotiation
  clock source < PTP master loopback IP Address>
```

The following table explains the parameters used in this example:

Table 6: Parameters for time interface and PTP domain configuration

Parameter	Description	Value Range	Default Value
ptp r-dti [id]		1-64	
description	R-DTI name or description		
ptp-domain [id]	Domain number of IEEE 1588	0-127	
local-priority [value]	Set local priority	128	128
priority1 [value]	Set priority1	0-255	128
priority2 [value]	Set priority2	0-255	255
mode [value]	R-DTI mode	other, slave master	slave
profile [value]	Set PTP ITU-T profile	default/G.8275.2	default
clock-port [id]	Configure clock port	1-32	

Parameter	Description	Value Range	Default Value
state [value]	Set Ethernet port admin status	other, up, down, testing	up
ethenet [value]	Set Ethernet port for clock port	0-32	The default value is clock port index
clock source [ip] gateway [ip]	Set clock address	ipv4 address, ipv6 address	
clock alternate-first	Select alternate source first		
transport [value]	Set transport encapsulation	other, ipv4, ipv6	ipv4
transport cos [value]	COS of 802.1Q	0-7	6
transport dscp [value]	DSCP of IP differentiated services	0-63	47
local-priority [value]	Set local priority	1-255	128
sync interval [value]	Set an interval for sync packets	0-7(-7 -0)	
announce interval [value]	Set an interval for announcement packets	0-3(-3 -0)	
delay-req interval [value]	Set an interval for PTP delay-req packets0-7(-7 -0)		
announce timeout [value]	Set timeout interval for announcement packets	3-255	
unicast grant-duration [value]	Set the grant duration time in seconds for unicast	60-1000	300
description	Clock port name or description		

Verifying Time Interface and PTP Domain Configuration

The following example shows how to verify the time interface and PTP domain configuration:

```
Router# show ptp clock running domain 0
Load for five secs: 5%/2%; one minute: 6%; five minutes: 6%
No time source, 15:16:20.421 CST Wed Mar 15 2017

                    PTP Ordinary Clock [Domain 0]
State          Ports Pkts sent Pkts rcvd Redundancy Mode
PHASE_ALIGNED  1     3687693   11177073  Hot standby
                            PORT SUMMARY
```

```
                                        PTP Master
Name           Tx Mode Role  Transport State Sessions Port Addr
slave-from-903 unicast slave Lo1588    Slave 2        10.10.10.11

                              SESSION INFORMATION
slave-from-903 [Lo1588] [Sessions 2]
Peer addr       Pkts in Pkts out In Errs Out Errs
10.10.10.11      5588900 1843789  0       0
10.10.10.12      5588173 1843904  0       0
```

Configure RPD PTP Connection

To configure RPD PTP connection, use the following commands.

```
enable
configure terminal
interface type [slot_#/]port_#
ptp r-dti 1 (RPD PTP connection)
 ptp-domain 0
 clock-port <same domain number with PTP server>
   clock source ip <IP Address> gateway ip <IP Address>
   clock source ip <IP Address> gateway ip <IP Address> alternate
  !--<clock-source is PTP master loopback ip, gw is the next hop to reach the ptp master
>--!
```

Verifying RPD PTP Connection Configuration

The following example shows how to verify the RPD PTP Connection configuration:

```
Router# show ptp clock 0 config
Domain/Mode         :   0/OC_SLAVE
Priority 1/2/local  : 128/255/128
Profile             : 001b19000100-000000 E2E
Total Ports/Streams : 1  /2
--PTP Port   1, Enet Port   1 ----
  Port local Address :10.10.10.11
  Unicast   Duration :300 Sync Interval : -4
  Announce  Interval :  0 Timeout       : 11
  Delay-Req Intreval : -4 Pdelay-req    : -4
  Priority  local    :128 COS:  6   DSCP: 47
  ==Stream 0 : Port 1  Master IP: 10.10.10.11
  ==Stream 1 : Port 1  Master IP: 10.10.10.11
```

Associate R-DTI with RPD

To associate R-DTthe local prefix SID associated to the segment ID, use the following commands.

```
enable
configure terminal
interface type [slot_#/]port_#
cable rpd node1
identifier 0044.4f04.0044 (node vbh0 mac)
 core-interface Te3/1/0
 rpd-ds 0 downstream-cable 3/0/0 profile 3
 rpd-us 0 upstream-cable 3/0/0 profile 3
r-dti 1
rpd-event profile 0
```

Verifying Associating R-DTI with RPD

The following example shows how to verify whether the RPD is associated to R-DTI:

```
Router# show running-config
Load for five secs: 8%/2%; one minute: 9%; five minutes: 9%
Time source is user configuration, 11:00:17.381 CST Wed Mar 22 2017
Building configuration...
Current configuration : 107879 bytes
!
! Last configuration change at 10:59:23 CST Wed Mar 22 2017
!
version 16.6
service timestamps debug datetime msec localtime show-timezone
service timestamps log datetime msec localtime show-timezone
service internal
no platform punt-keepalive disable-kernel-core
platform ipccl log-history 0
platform punt-policer 10 10
platform punt-policer 10 10 high
platform punt-policer 80 10
platform punt-sbrl subscriber rate no-drop
platform shell
!
hostname RphyNode-L09
!
boot-start-marker
boot system harddisk:cbrsup-universalk9.16.05.01prd9.SPA.bin
boot-end-marker
!
!
----
!
cable tag 10
 name docsis1.0
 docsis-version docsis10
!
cable tag 11
 name docsis1.1
 docsis-version docsis11
!
-----
cable load-balance docsis-group 1
 restricted
 upstream Upstream-Cable 3/0/3 us-channel 0-3
 method utilization
 threshold load 15
 threshold load minimum 2
 policy pure-ds-load
 init-tech-list 4
 interval 60
 tag docsis1.0
 tag docsis1.1
 tag docsis2.0
 tag docsis3.0
!
---
cable metering ipdr-d3 session 1 type 1
cable metering source-interface TenGigabitEthernet4/1/1
cable modem remote-query 30 public
cable modem vendor 00.02.00 "Apache-ACB"
cable modem vendor E8.6D.52 "Motorola"
cable modem vendor 00.1F.E1 "Ambit"
cable modem vendor 00.1F.E2 "Ambit"
```

```
cable modem vendor 00.D0.DD "Sunrise"
!
!
----
!
no network-clock synchronization automatic
!
ptp clock boundary domain 0
 servo tracking-type R-DTI
 clock-port slave-from-903 slave
  delay-req interval -4
  sync interval -5
  sync one-step
  transport ipv4 unicast interface Lo1588 negotiation
  clock source 10.10.10.11
  clock source 192.168.0.0
 clock-port master-local master
  transport ipv4 unicast interface Lo1588 negotiation
!
-----
r-dti 2
 rpd-event profile 0
!
ptp r-dti 2
 ptp-domain 0
 clock-port 1
   clock source ip 10.10.10.11
   clock source ip 192.168.0.0 alternate
!
ptp r-dti 3
 ptp-domain 0
 clock-port 1
   clock source ip 10.10.10.11
   clock source ip 192.168.0.0 alternate
!
ptp r-dti 10
 ptp-domain 0
 clock-port 1
   clock source ip 10.10.10.11
   clock source ip 192.168.0.0 alternate
   announce interval -3
   announce timeout 3
!
ptp r-dti 11
 ptp-domain 0
 priority1 101
 priority2 102
 local-priority 100
 clock-port 2
   ethernet 1
   clock alternate-first
   clock source ip 10.10.10.11
   clock source ip 192.168.0.0 alternate
   transport cos 0
   transport dscp 63
   sync interval -1
   announce timeout 255
   delay-req interval -7
   unicast grant-duration 60
   local-priority 255
!
ptp r-dti 12
 ptp-domain 0
 clock-port 1
```

```
   ethernet 0
   clock source ip 10.10.10.11
!
ptp r-dti 60
 ptp-domain 0
!
cable video
!
end
```

Verifying PTP Clock Functioning

To verify whether the PTP Clock is running, use the following commands:

```
Router#show ptp clock running
Load for five secs: one minute: 5%; five minutes:
Time source is NTP, 14 CST Fri Feb 17 2017
PTP Ordinary clock [Domain 0]
State         Ports pkts sent pkts rcvd Redundancy Mode
PHASE-ALIGNED 1     7339500   22245593  Hot standby
   Port Summary
Name           Tx Mode Role  Transport State Sessions PTP Master Port Addr
slave-from-903 unicast slave  L01588    Slave 2        10.10.10.11
```

Verifying PTP Clock Running Domain

The following example shows how to verify the PTP clock running domain:

```
Router#show ptp clock running domain 0
Load for five secs: 5%/2%; one minute: 6%; five minutes: 6%
No time source, 15:16:20.421 CST Wed Mar 15 2017
                      PTP Ordinary Clock [Domain 0]
State          Ports Pkts sent Pkts rcvd Redundancy Mode
PHASE_ALIGNED  1     3687693   11177073  Hot standby
                               PORT SUMMARY
                                          PTP Master
Name           Tx Mode Role  Transport State Sessions Port Addr
slave-from-903 unicast slave Lo1588    Slave 2        10.10.10.11

                              SESSION INFORMATION
slave-from-903 [Lo1588] [Sessions 2]
Peer addr       Pkts in Pkts out In Errs Out Errs
10.10.10.11      5588900 1843789  0       0
192.168.0.10     5588173 1843904  0       0
```

Verifying Time Sync State

To verify the status of time synchronization, use the show ptp clock <n> state command as given in the following example:

```
Router# show ptp clock 0 state
apr state       : PHASE_LOCK
clock state     : SUB_SYNC
current tod     : 1485414295   Thu Jan 26 07:04:55 2017
active stream   : 0
==stream    0   :
  port id       :                0
  master ip     :       10.10.10.11
  stream state  :       PHASE_LOCK
  Master offset :             -405
```

```
  Path    delay :           -17071
  Forward delay :           -17476
  Reverse delay :           -16623
  Freq offset   :          -291143
  1Hz  offset   :             -676
==stream    1   :
  port id       :                0
  master ip     :      192.168.0.11
  stream state  :       PHASE_LOCK
  Master offset :             -369
  Path    delay :            -1619
  Forward delay :            -1988
  Reverse delay :            -1260
  Freq offset   :          -297905
  1Hz  offset   :             -664
```

Verifying Time Sync Statistics

To verify the statistics of the time synchronization, use the show ptp clock <n> state command as given in the following example:

```
Router# show ptp clock 0 statistics
 AprState    4  :
  2@0-00:06:51.568 1@0-00:06:41.930 0@0-00:04:17.925
  4@0-00:03:58.724
 ClockState  5  :
  5@0-00:07:12.640 4@0-00:07:10.182 3@0-00:07:06.825
  2@0-00:06:51.825 1@0-00:06:51.530
 BstPktStrm  1  :
  0@0-00:06:42.029
 SetTime     1  :
  1000000000@0-00:04:00.045
 StepTime    1  :
  125126755@0-00:06:14.670
 AdjustTime  64 :
  -676@0-07:34:32.546 -733@0-07:33:31.545  -838@0-07:32:30.546
  -892@0-07:31:29.545 -935@0-07:30:28.545 -1033@0-07:29:27.545
  -914@0-07:28:26.546  916@0-07:26:24.545  2507@0-07:25:18.170
streamId  msgType           rx     rxProcessed lost        tx
 0        SYNC              433439 433439      4294574083  0
 0        DELAY REQUEST     0      0           0           433439
 0        P-DELAY REQUEST   0      0           0           0
 0        P-DELAY RESPONSE  0      0           0           0
 0        FOLLOW UP         0      0           0           0
 0        DELAY RESPONSE    433437 433437      4294548766  0
 0        P-DELAY FOLLOWUP  0      0           0           0
 0        ANNOUNCE          27098  27098       0           0
 0        SIGNALING         285    285         0           285
 0        MANAGEMENT        0      0           0           0
   TOTAL                    894259 894259      8589122849  433724
 1        SYNC              433435 433435      4294574085  0
 1        DELAY REQUEST     0      0           0           433439
 1        P-DELAY REQUEST   0      0           0           0
 1        P-DELAY RESPONSE  0      0           0           0
 1        FOLLOW UP         0      0           0           0
 1        DELAY RESPONSE    10351  10351       4104        0
 1        P-DELAY FOLLOWUP  0      0           0           0
 1        ANNOUNCE          27098  27098       4294901760  0
 1        SIGNALING         285    285         0           285
 1        MANAGEMENT        0      0           0           0
   TOTAL                    471169 471169      8589479949  433724
```

Configuration Examples

This section provides examples for configuring Cisco cBR for time synchronization.

Example: Configuring Time Interface and PTP Domain

The following example shows how to configure time interface and PTP domain:

```
enable
configure terminal
interface Loopback1588
ip address 10.10.10.11 255.255.255.224

interface TenGigabitEthernet5/1/3 (connect to PTP master)
ip address 192.168.0.13 255.255.255.224

ip route 10.10.10.11 255.255.255.224 192.168.0.12   (route to PTP master loopback ip)

ptp clock ordinary domain 0 (This is for cbr ptp connection)
 servo tracking-type R-DTI
 clock-port slave-from-903 slave
 delay-req interval -4
 sync interval -5
 sync one-step
 transport ipv4 unicast interface Lo1588 negotiation
 clock source 10.10.1.11 (PTP master loopback ip)
```

Example: Configure RPD PTP Connection

The following example shows how to configure RPD PTP connection:

```
enable
configure terminal
ptp r-dti 1
ptp-domain 0
 mode slave
 priority1 128
 priority2 255
 local-priority 128
 clock-port 1
   ethernet 1
   …
 clock-port 2
   ethernet 2
   …
clock-port 1
   ethernet 1
   state up
   transport ipv4
   clock source ip 10.10.1.12 gw 10.10.1.1
    clock source ip 192.168.0.0 gateway ip 10.10.1.2 alternate
   transport cos 6
   transport dscp 47
   sync interval -4
   announce interval 0
   announce timeout 11
   delay-req interval -4
   unicast grant-duration 300
   local-priority 128
```

Example: Associate R-DTI with RPD

The following example shows how to associate R-DTI with RPD:

```
enable
configure terminal
cable rpd node1
 identifier 0004.9f03.0061 (node vbh0 mac)
 core-interface Te3/1/0
 rpd-ds 0 downstream-cable 3/0/0 profile 3
 rpd-us 0 upstream-cable 3/0/0 profile 3
r-dti 1
 rpd-event profile 0
```

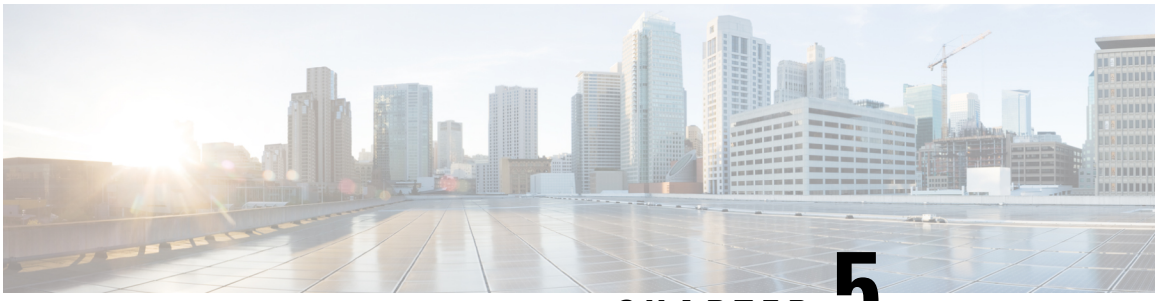
Feature Information for Synchronizing Time on R-PHY Devices

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 www.cisco.com/go/cfn 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 7: Feature Information for Synchronizing Time on R-PHY Devices

Feature Name	Releases	Feature Information
Synchronizing Time on R-PHY Devices	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.



CHAPTER 5

DEPI/UEPI/L2TP integration with Cisco Remote PHY Device

This document describes how to configure the DEPI/UEPI/L2TP integration with RPD on the Cisco cBR Series Converged Broadband Router.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 8: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information about DEPI/UEPI/L2TP integration with RPD

DEPI

Downstream External PHY Interface (DEPI) is the downstream interface between the CCAP Core and the RPD. R-DEPI is based on DEPI. More specifically, it is an IP pseudowire between the MAC and PHY in an MHAv2 system that contains both a data path for DOCSIS frames, video packets, and OOB packets, as well as a control path for setting up, maintaining, and tearing down sessions.

UEPI

Upstream External PHY Interface (UEPI) is the upstream interface between the RPD and the CCAP Core. Like DEPI, it is an IP pseudowire between the PHY and MAC in an MHAv2 system that contains both a data path for DOCSIS frames, and a control path for setting up, maintaining, and tearing down sessions.

How to Configure DEPI/UEPI/L2TP integration with RPD

This section describes how to configure DEPI/UEPI/L2TP integration with RPD.

Configuring depi-class/l2tp-class Pair

It's not permitted to change the default l2tp-class configuration (rphy-l2tp-global-class) for R-DEPI by user, because the parameter values are fine tuned to accommodate most common cases.

If user wants to use parameter values other than the default ones, they can use manually defined depi-class/l2tp-class pair. To do so, follow the example below:

```
Router# configure terminal
Router(config)# l2tp-class l2tp_demo
Router(config-l2tp-class)#exit
Router(config)# depi-class depi_demo
Router(config-depi-class)#l2tp-class l2tp_demo
Router(config-depi-class)#exit
Router(config)#cable rpd node
Router(config-rpd)#core-interface Te1/1/7
Router(config-rpd-core)#depi depi_demo /* Be sure to configure when the RPD core is offline*/
Router(config-rpd-core)#end
```

Verifying the RPD Status

To verify the RPD status, use the **show cable rpd** command as shown in the example below:

```
Router# show cable rpd
Load for five secs: 6%/1%; one minute: 5%; five minutes: 5%
No time source, *04:52:03.936 UTC Tue Jan 17 2017

MAC Address     IP Address    I/F      State       Role   HA    Name
0004.9f00.0901  91.0.10.10    Te1/1/0  init(l2tp)  Pri    Act   node
```

Display DEPI Ralated Information

To display the Downstream External PHY Interface (DEPI) related information, use the command as shown in the following example:

```
Router#show cable rpd depi

DEPI Tunnel and Session Information Total tunnels 1 sessions 26
LocTunID   RemTunID   Remote Device  State  Remote Address  Sessn L2TP Class
                                                           Count
338514820  671581873  0004.9f00.0901 est    10.10.10.11     26    rphy-l2tp-gl...

LocID      RemID      Pseudowire      State  Last Chg Uniq ID    Type Mode RemSt
0x41040008 0x00000B02 US1/0/0:2(R)    est    00:34:57 21          P    PSP  UP
0x41010000 0x00000600 US1/0/0:0(D)    est    00:34:57 11          P    PSP  UP
0x00002006 0x00000405 DS1/0/0:5       est    00:34:57 6           P    PSP  UP
0x00002004 0x00000403 DS1/0/0:3       est    00:34:57 4           P    PSP  UP
0x4100000C 0x00000D03 US1/0/0:3(M)    est    00:34:57 23          P    PSP  UP
0x00002002 0x00000401 DS1/0/0:1       est    00:34:57 2           P    PSP  UP
0x00002007 0x00000406 DS1/0/0:6       est    00:34:57 7           P    PSP  UP
0x00002008 0x00000407 DS1/0/0:7       est    00:34:57 8           P    PSP  UP
0x4101000C 0x00000603 US1/0/0:3(D)    est    00:34:57 24          P    PSP  UP
0x41000004 0x00000D01 US1/0/0:1(M)    est    00:34:57 15          P    PSP  UP
0x00002001 0x00000400 DS1/0/0:0       est    00:34:57 1           P    PSP  UP
0x41080008 0x00000F02 US1/0/0:2(S)    est    00:34:57 22          P    PSP  UP
0x41010004 0x00000601 US1/0/0:1(D)    est    00:34:57 16          P    PSP  UP
0x41020000 0x00000800 US1/0/0:0(B)    est    00:34:57 12          P    PSP  UP
0x00002009 0x00000408 DS1/0/0:8       est    00:34:57 9           P    PSP  UP
0x41010008 0x00000602 US1/0/0:2(D)    est    00:34:57 20          P    PSP  UP
0x41000008 0x00000D02 US1/0/0:2(M)    est    00:34:57 19          P    PSP  UP
```

```
0x4108000C 0x00000F03 US1/0/0:3(S)     est     00:34:57 26          P     PSP  UP
0x00002003 0x00000402 DS1/0/0:2        est     00:34:57 3           P     PSP  UP
0x41080000 0x00000F00 US1/0/0:0(S)     est     00:34:57 14          P     PSP  UP
0x41040004 0x00000B01 US1/0/0:1(R)     est     00:34:57 17          P     PSP  UP
0x41080004 0x00000F01 US1/0/0:1(S)     est     00:34:57 18          P     PSP  UP
0x41000000 0x00000D00 US1/0/0:0(M)     est     00:34:56 10          P     PSP  UP
0x00002005 0x00000404 DS1/0/0:4        est     00:34:56 5           P     PSP  UP
0x4104000C 0x00000B03 US1/0/0:3(R)     est     00:34:56 25          P     PSP  UP
0x41040000 0x00000B00 US1/0/0:0(R)     est     00:34:56 13          P     PSP  UP

outer#show cable rpd 0004.9f03.0214 te7/1/0 depi tunnel

Load for five secs: 7%/2%; one minute: 6%; five minutes: 6%
No time source, *12:41:44.228 CST Mon Mar 20 2017

LocTunID   RemTunID   Remote Device  State  Remote Address  Sessn L2TP Class
                                                           Count
3388764998 1054297851 0004.9f03.0214 est    10.10.10.11     29    rphy-l2tp-gl...
```

Table 9: show cable rpd depi Field Descriptions

Field	Description
LocID	Local session ID.
RemID	Remote session ID.
US1/0/0:2(R)	US means UEPI session, DS means DEPI session. This string means UEPI session on line card slot 1, controller 0, rf-channel 2.
est in State	Established state.
P in Type	On primary line card.

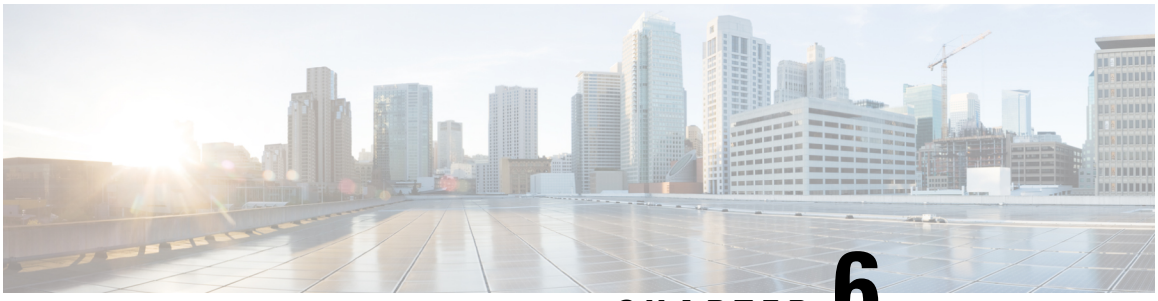
Feature Information for DEPI/UEPI/L2TP integration with RPD

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

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

Table 10: Feature Information for DEPI/UEPI/L2TP integration with RPD

Feature Name	Releases	Feature Information
DEPI/UEPI/L2TP integration with RPD	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.



CHAPTER 6

DEPI Latency Measurement

This document describes how to configure the DEPI latency measurement on the Cisco cBR Series Converged Broadband Router.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 11: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information about DEPI Latency Measurement

The DEPI Latency Measurement (DLM) packet is a specific type of data packet used for measuring the network latency between the CCAP core and the RPD. There are two types of DLM packets, ingress DLM packet and egress DLM packet. The ingress DLM measures the latency between the CCAP core and the ingress point in the RPD, and the egress DLM measures the latency between the CCAP core and the egress point of the RPD. For now, only the ingress DLM is supported. Egress DLM will be supported in the future if required.

How to Configure DLM

This section describes how to configure DLM on Cisco cBR-8.

Configuring DLM

To configure DLM, complete the following procedure. DLM is disabled by default, only enabled when configured.

```
configure terminal
cable rpd name
core-interface interface_name
network-delay dlm interval_in_seconds
```

Verifying DLM Configuration

To verify the DLM configuration, use the **show cable rpd dlm** command as shown in the example below:

```
Router# show cable rpd 0000.bbaa.0002 dlm
Load for five secs: 4%/1%; one minute: 4%; five minutes: 4%
Time source is NTP, 13:12:36.253 CST Sun Jan 1 2017
DEPI Latency Measurement (ticks) for 0000.bbaa.0002
 Last Average DLM:              4993
 Average DLM (last 10 samples): 4990
 Max DLM since system on:       5199
 Min DLM since system on:       4800
 Sample #     Latency (usecs)
 x------------x------------
 0            491
 1            496
 2            485
 3            492
 4            499
 5            505
 6            477
 7            474
 8            478
 9            471
```

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

Table 12: show cable rpd dlm Field Descriptions

Field	Description
Last Average DLM	It means the last time average DLM (AD). At first, the Last Average DLM (LAD) is always 0, when the absolute value of (LAD - AD) exceeds or equal to 75us, LAD will be updated to be the value of AD, MAP advance triggered to update, AD will keep updating with the last (latest) 10 samples.

Example: DLM Configuration

The following example shows how to configure DLM:

```
Router# configure terminal
Router(config)#cable rpd 1
Router(config-rpd)#core-interface tenGigabitEthernet 3/1/0
Router(config-rpd-core)#network-delay dlm 10
```

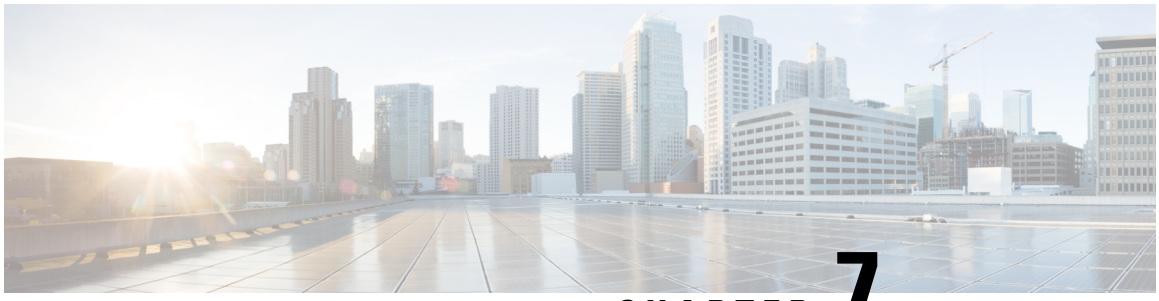
Feature Information for DLM

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

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

Table 13: Feature Information for DLM

Feature Name	Releases	Feature Information
DEPI Latency Measurement	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.



CHAPTER 7

Multiple Cores

This document describes the multiple cores in the Remote PHY system.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 14: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information about Multiple Cores

The RPD can be managed by more than one CCAP core. An RPD is controlled by exactly one principal CCAP core and zero or more auxiliary CCAP core(s). Each CCAP core manages a subset of RPD resources, e.g., particular channels or RF ports.

Principal core is responsible for the configuration of common parameters for the RPD and for certain device management functions. Principal core can provide DOCSIS, video or OOB service. Auxiliary cores are responsible for providing video or OOB services. They are restricted to the resource set assigned to them by the principal core.

Restrictions for Multiple Cores Configuration

The following restrictions are applicable to mutiple cores configuration:

- Maximum four cores are supported.
- DOCSIS controllers can only be configured to principal core, while video controllers can be configured to all cores.
- Only one core can be principal, the rest will be auxiliary.

- Principal core needs to be configured explicitly.
- At least one DOCSIS downstream controller and one upstream controller are needed for principal core.
- No upstream controller for auxiliary core and at least one downstream controller is needed for auxiliary core.
- Only single CMTS is supported.
- No downstram frequency and channel id overlap is allowed for all the cores.

How to Configure Multiple Cores

This section describes how to configure multiple cores on Cisco cBR-8.

Configuring Multiple Cores

To configure the multiple cores, follow the example below:

```
Router(config)# cable rpd sjc_block22   /* unique name for each rpd */
Router(config-rpd)# description rpd for sjc block 22
Router(config-rpd)# identifier 1122.3344.5566   /* unique id for each rpd.*/
Router(config-rpd)# rpd-ds 0 power-level 5   /* DS max-carrier and power-level info */
Router(config-rpd)# rpd-ds 0 dedicated-cw-tone cw1   /* DS pilot tone info */
Router(config-rpd)# core-interface Te3/1/0   /* Core side interface (D-PIC interface) for
services below */
Router(config-rpd-core)# principal   /* Specify the principal core */
Router(config-rpd-core)# rpd-ds 0 controller downstream-cable 3/0/0 profile 100 /* DS docsis
 channel config*/
Router(config-rpd-core)# rpd-ds 0 controller downstream-cable 3/0/1 profile 200 /* DS docsis
 channel config*/
Router(config-rpd-core)# rpd-ds 0 downstream-cable 3/0/2 profile 300 /* DS video channel
config*/
Router(config-rpd-core)# rpd-ds 0 downstream-cable 3/0/3 profile 400 /* DS video channel
config*/
Router(config-rpd-core)# rpd-us 0 upstream-cable 3/0/0 profile 101 /* US 0 docsis channel
config*/
Router(config-rpd-core)# rpd-us 1 upstream-cable 3/0/1 profile 101   /* US 1 docsis channel
 config*/
Router(config-rpd-core)# depi depi_rpd_block22    /* RPD DEPI configuration.*/
Router(config-rpd-core)# exit
Router(config-rpd)# core-interface Te9/1/1 /* Support multiple core-interface for cases
such as video is using separate LC*/
Router(config-rpd-core)# rpd-ds 0 downstream-cable 9/0/1 profile 200  /* DS video channel
config*/
Router(config-rpd-core)# depi depi_rpd_block22    /* RPD DEPI configuration.*/
Router(config-rpd-core)# exit
Router(config-rpd)# r-dti 1
Router(config-rpd)# rpd-event profile 0
```

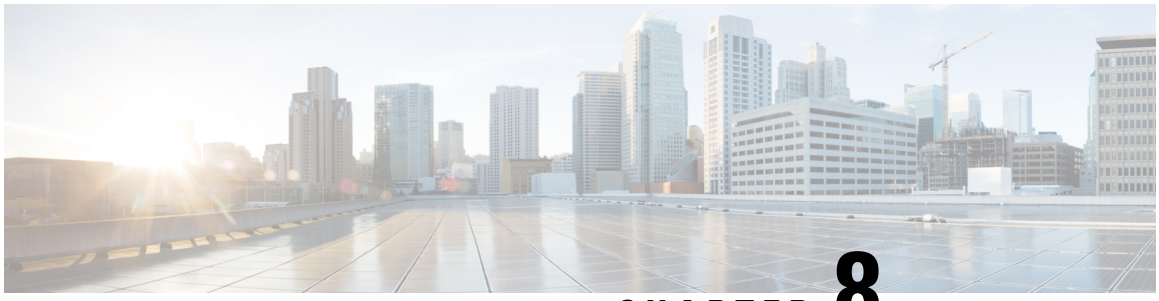
Verifying Multiple Cores Configuration

To display the information of the principal and auxiliary cores, use the **show cable rpd** command as shown in the example below:

```
Router# show cable rpd
MAC Address     IP Address         I/F          State        Role HA  Name
```

```
0004.9f00.0907  120.100.2.20     Te1/1/6   online       Pri   Act  node
0004.9f00.0907  120.100.2.20     Te1/1/0   online       Aux  Act  node
0004.9f00.0907  120.100.2.20     Te1/1/1   online       Aux  Act  node
0004.9f00.0907  120.100.2.20     Te1/1/2   online       Aux  Act  node
```

Note Only the active cores are displayed, stand-by cores are hidden.



CHAPTER 8

GCPP Support for Remote PHY

This document provides information on the Generic Control Protocol Principal (GCPP) support on Cisco cBR-8 series routers.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

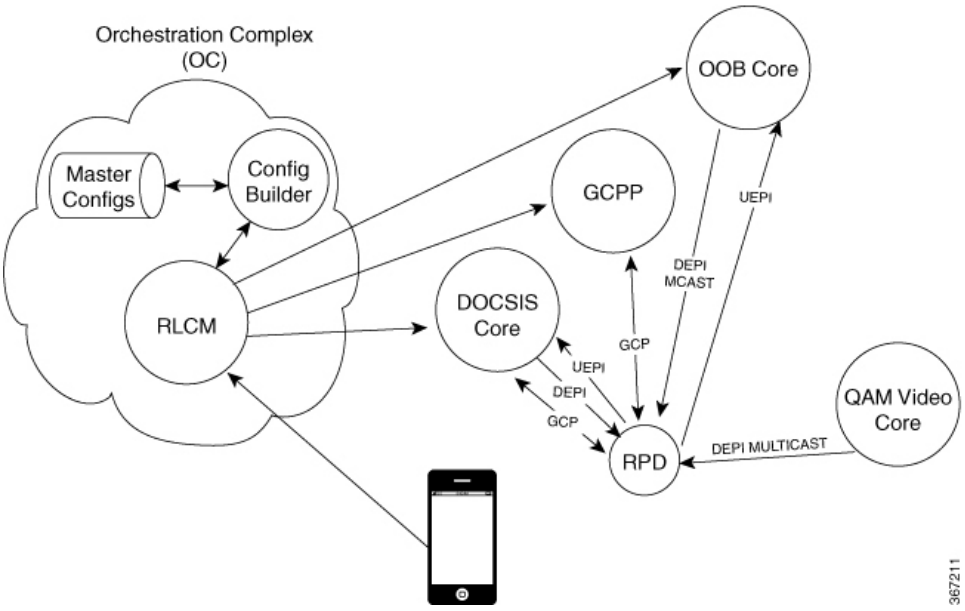
Information About GCPP Support

The Generic Control Protocol (GCP) sets up a control plane tunnel over a generic transport protocol such as TCP or UDP. GCP is used to program the remote PHY system upstream and downstream parameters from the CMTS. It is also used to control the remote PHY system.

The Remote PHY architecture with GCPP (Generic Control Protocol Principal) server, includes separate DOCSIS, QAM video and OOB cores. To enable the use of multiple RPHY cores, the architecture utilizes a GCP Principal Core (GCPP). Initially, the RPDs contact and authenticate with the GCPP core, which also configures the RPDs in its domain in coordination with the Cores (DOCSIS, QAM video, and OOB).

Without the GCPP core, cBR8 is the principal core for RPD. However, in this GCPP architecture, the GCPP server is the principal core and the Cisco cBR8 is an auxiliary core.

Figure 6: Remote PHY Architecture with GCPP



Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 15: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

GCPP Core

GCPP core provides containerized services for automating deployments, managing applications, the initial authentication of the RPDs, and configuring RPD features and video services. The Principal Core does not provide any services (video or data).

The GCPP configures RPDs using GCP with the details of the other Cores that will configure it and the resources that will be configured by those Cores. The GCPP then performs the RPD operational configuration and the video and OOB service configuration. By the end of this process, the RPD will have its operational configuration and video and OOB services set up.

The GCPP core performs the following three primary functions:

- Initial authentication of the RPD
- Initial configuration of the RPD, including the list of cores to which it connects and the resources that those other cores will configure
- Configuration of the multicast sources that the RPD uses to populate QAM video (broadcast and narrowcast) channels

GCPP allows integrating videos on a standardized, single video platform. It also provides the configuration of the RPD's video channels, removing the requirements from the Video Core to support RPD authentication and GCP configuration.

How to Configure GCPP Core

Note To know more about the commands referenced in this section, see the Cisco IOS Master Command List.

This section contains the following:

Adding GCPP Core IP Address

Add the GCPP core IP address in the original CNR RPD policy if your RPD helper address is cnr8/auto-cnr. Or add the DHCP pool with the GCPP core/CCAP core in the USD.

Configuring Cisco cBR for Enabling GCPP

To set the GCPP server as the core server, configure Cisco cBR to remove the principal keyword under RPD configuration.

```
cable rpd <RPD name>
 identifier <RPD ID>
 core-interface <slot/subslot/port>
  principal             <<<<<<<<<<< remove it, gcpp is the principal core
  rpd-ds <port-ID> downstream-cable <slot/sub-slot/controller> profile <ID>
  rpd-us <port-ID> upstream-cable <slot/sub-slot/controller> profile <ID>
 core-interface <slot/subslot/port>
  rpd-ds <port-ID> downstream-cable <slot/sub-slot/controller> profile <ID>
r-dti <ID>
 rpd-event profile <ID>
```

Configuration Example

This section provides example of Cisco cBR-8 Converged Broadband Router configuration when GCPP is the core.

Example: GCPP Configuration

```
cable rpd p1_0719
 identifier 0004.9f00.0719
 core-interface Te6/1/2
  rpd-ds 0 downstream-cable 6/0/17 profile 7
  rpd-us 0 upstream-cable 6/0/17 profile 7
 core-interface Te6/1/1
  rpd-ds 0 downstream-cable 6/0/3 profile 17
r-dti 6
 rpd-event profile 0
```

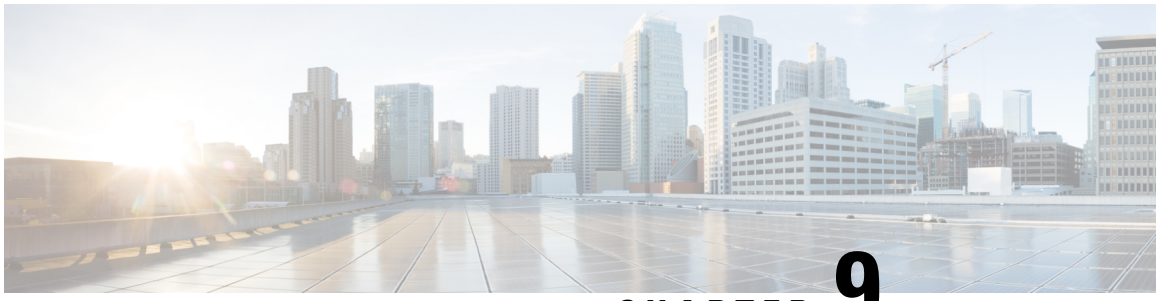
Feature Information for GCPP Support

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 www.cisco.com/go/cfn 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 16: Feature Information for GCPP Support

Feature Name	Releases	Feature Information
GCPP Support	Cisco 1x2 RPD Software 4.1	This feature was introduced on the Cisco Remote PHY Devices.



CHAPTER 9

IKEv2 Mutual Authentication

This document describes the Remote PHY device IKEV2 mutual authentication on the Cisco cBR Series Converged Broadband Router.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 17: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information about IKEv2 Mutual Authentication

When the RPD connects to the CCAP Core, a mutual authentication using IKEv2 with public key signatures is optionally required and a secure control session may be established which can be secured using IPsec.

Mutual authentication is optionally required between the RPD and CCAP Core, and a secure connection may not be required in all cases. Whether authentication is required for an RPD is determined by the network that it is connected to. In some cases, RPD is located in an untrusted network, and it must connect to devices inside the trusted network, which presents a potential security vulnerability.

Authentication is initiated by RPD. Whether the RPD is required to authenticate is under control of the CCAP Core.

Configure IKEv2 Mutual Authentication

This section describes how to configure IKEv2 mutual authentication for RPD.

Note To know more about the commands referenced in this module, see the Cisco IOS Master Command List.

CMTS Side Configuration

Global Configuration

To enable IKEv2 mutual authentication, use **cable rphy auth enable** command in the global configuration mode.

Per PRD Configuration

To configure the IKEv2 mutual authentication per PRD, use **ikev2-core authentication {enable | disable | bypass}** command in the RPD configuration mode.

To display the authentication state, use **show cable rpd** command as shown in the following example:

```
Router#show cable rpd
Load for five secs: 5%/1%; one minute: 4%; five minutes: 5%
Time source is NTP, 10:08:45.016 CST Mon Sep 4 2017
MAC Address     IP Address       I/F       State        Role  HA    Auth   Name
0004.9f00.0719  6.6.6.100        Te6/1/2   online       Pri   Act   Y      p1_0719
0004.9f00.0719  6.6.6.100        Te6/1/1   online       Aux   Act   Y      p1_0719
badb.ad13.411c  6.6.6.101        Te6/1/2   onlisssne    Pri   Act   Y      p2_411c
badb.ad13.411c  6.6.6.101        Te6/1/1   online       Aux   Act   Y      p2_411c
```

Note If RPD IKEv2 authentication is enabled, and RPD Core is authenticated, then the column of "auth" will show "Y". If RPD IKEv2 authentication is enabled, and RPD Core is not authenticated, then the column of "auth" will show "N". If RPD IKEv2 authentication is disabled, the column of "auth" will show "N/A".

RPD Node Side Configuration

To configure the IKEv2 mutual authentication on RPD node, use **ikev2 authentication {enable | disable}** command on RPD node.

To display the authentication configuration state, use **show ikev2** command as shown in the following examples:

```
R-PHY#show ikev2 configuration
IKEv2 authentication is currently enabled, next boot is enabled!

R-PHY#show ikev2 session
Local      Remote     Status
6.6.6.100  6.6.6.1    UP
```

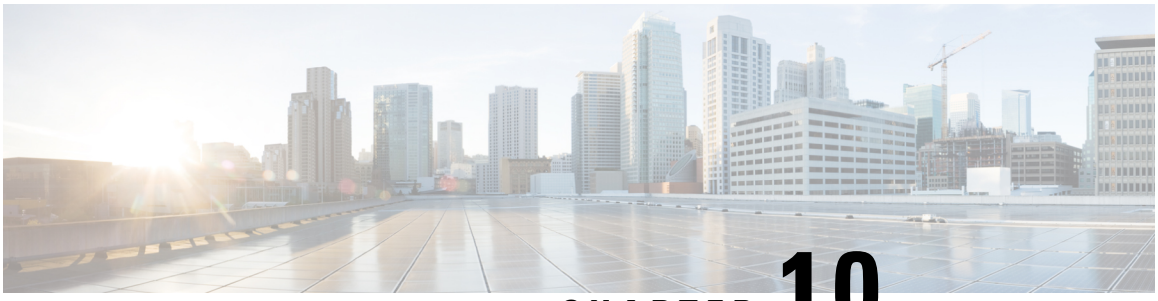
Feature Information for IKEv2 Mutual Authentication

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 www.cisco.com/go/cfn 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 18: Feature Information for IKEv2 Mutual Authentication

Feature Name	Releases	Feature Information
IKEv2 Mutual Authentication	Cisco 1x2 / Compact Shelf RPD Software 4.1	This feature was introduced on the Cisco Remote PHY Device.



CHAPTER 10

Power Configuration for Compact Shelf

This document describes how to configure the RF channel's power level, the input power level for the upstream radio frequency (RF) carrier, and the base channel power level for Compact Shelf.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 19: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information about Power Configuration for Compact Shelf

For Compact Shelf, new commands have been added to configure RF channel's power level, the input power level for the upstream radio frequency (RF) carrier, and the base channel power level.

How to Configure Base Power, Downstream Power Level, and Upstream Power Level

This section describes how to configure base power, downstream power level, and upstream power level on Compact Shelf.

Configuring Maximum Carriers

To configure the maximum number of carriers, complete the following procedure. The default number of maximum carriers specified is 158. The maximum number of carrier ranges from 1–158.

```
configure terminal
cable rpd name
rpd-ds port max-carrier value
```

This is an example of maximum carrier configuration:

```
Router# configure terminal
Router(config)#cable rpd node6
Router(config-rpd)#rpd-ds 0 max-carrier 128
```

Configuring Base Channel Power Level

To set the base channel power level, complete the following procedure. The base channel powel level range is 25–34.

```
configure terminal
cable rpd name
rpd-ds port base-power value
```

This is an example of base channel power level configuration.

```
Router# configure terminal
Router(config)#cable rpd node6
Router(config-rpd)# rpd-ds 0 base-power 30
```

Configuring RF Channel Power Level

To adjust the RF channel's power level, complete the following procedure. The RF channel power level range is 7–23

```
configure terminal
cable rpd name
rpd-ds port rf-channel number power-adjust value
```

This is an example of RF channel power power level.

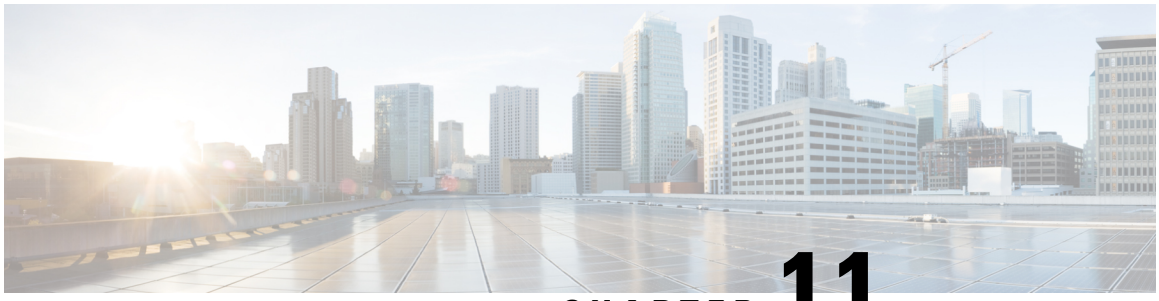
```
Router# configure terminal
Router(config)#cable upstream controller-profile 221
Warning: changes to this profile will affect the following controllers:
         9/0/10,

Confirm to continue? [no]: yes
Router(config-controller-profile)#us
Router(config-controller-profile)#us-channel 0 pow
Router(config-controller-profile)#us-channel 0 power-level ?
  <-7 - 25>  Power level in dBmV(-4~25 for rphy-node, -7~23 for rphy-shelf)

Router(config-controller-profile)#us-channel 0 power-level 23
```

PART II

Remote PHY System High Availability



CHAPTER 11

Cisco Remote PHY Line Card and Supervisor Redundancy

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 20: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

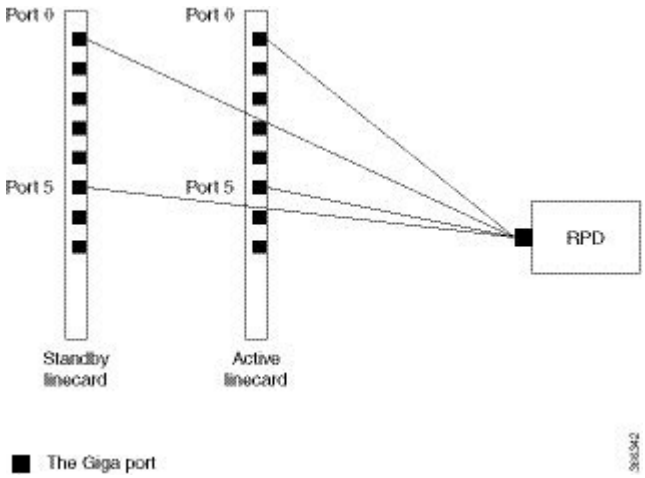
Information About Remote PHY Line Card and Supervisor Redundancy

Line Card Redundancy

In Remote PHY (R-PHY) configuration, RPDs connect to both active linecard and standby linecard, and have active connections to active linecard, standby connections to standby linecard. From RPD side, it connects to active core and standby core independently.

Each RPD has one principal core, and may have several auxiliary cores. LCHA needs to support multiple cores. These cores are on the same linecard or different linecards. The port on the standby linecard can protect all the same ports on the active linecards.

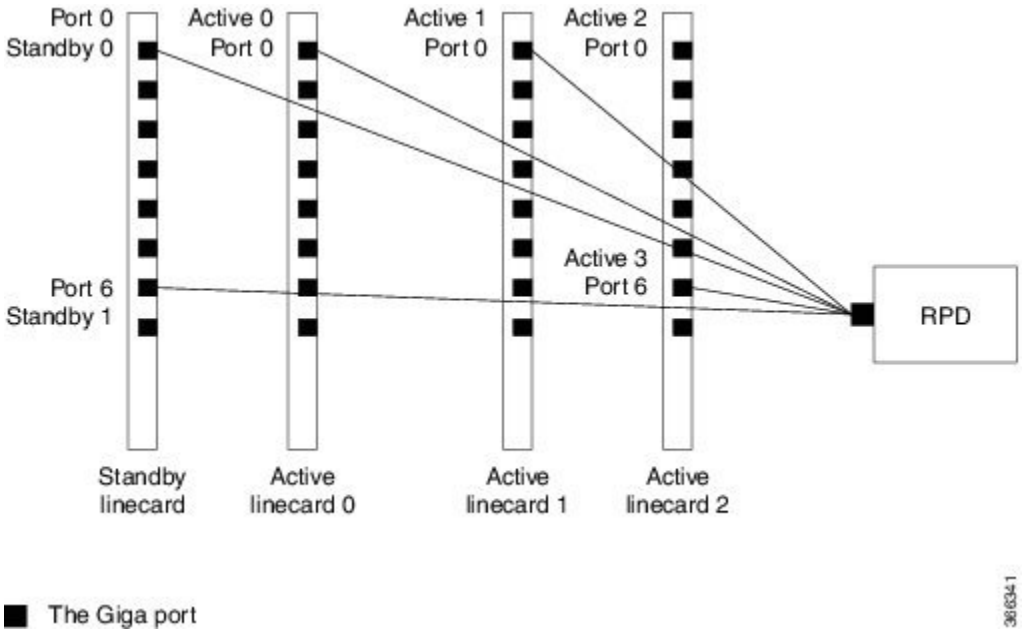
Figure 7: Multiple cores on the same line card



In the figure above, the RPD has multiple cores connected to the same active linecard. In order to support LCHA, RPD needs to connect to the same port on the standby linecard. In this way, RPD has several standby cores to protect the active cores. The standby core have the same resource as the active core.

When multiple cores connect to different active linecards, if they connect to different ports of the linecard, there will have different standby cores. If active core connects to the same port on different linecard, they share one standby core.

Figure 8: Multiple cores on different line cards



In the figure above, RPD have two standby cores. One standby core connects to port 6 of the standby linecard, it can protect the active core which connects to port 6 of the active linecard 2. The other standby core connects to port 0 of the standby linecard, it can protect the active cores connect to port 0 of linecard 0 and linecard 1. So for the standby core 0, it contains the resource for both active core 0 and active core 1.

When active linecard 0 fails over to standby linecard, the standby core 1 will be deleted, the standby core 0 will bring the resource of active core 0 to active. When linecard 2 fails over to standby linecard, the standby core 0 will be deleted, and standby core 1 will become active for active core 3.

For more information about Line Card Redundancy, see Line Card Redundancy.

Supervisor Redundancy

Compared to the SUP high availability recover process in iCMTS configuration, the Remote PHY SUP high availability recover process has RPD status change as shown in the example below:

```
show cable rpd 0004.9f00.0625 lcha-cores
MAC Address     IP Address    I/F        State         Role  HA   Name
0004.9f00.0625  120.105.6.10  Te0/1/1    recovering    Pri   Act  node1
0004.9f00.0625  120.105.6.10  Te9/1/1    recovering    NA    Sby  node1

show cable rpd 0004.9f00.0625 lcha-cores
MAC Address     IP Address    I/F        State         Role  HA   Name
0004.9f00.0625  120.105.6.10  Te0/1/1    init(l2tp)    Pri   Act  node1
0004.9f00.0625  120.105.6.10  Te9/1/1    init(l2tp)    NA    Sby  node1

show cable rpd 0004.9f00.0625 lcha-cores
MAC Address     IP Address    I/F        State         Role  HA   Name
```

```
0004.9f00.0625  120.105.6.10  Te0/1/1     online          Pri    Act  node1
0004.9f00.0625  120.105.6.10  Te9/1/1     online          NA     Sby  node1
```

The status of the RPD changes from recovering to online, indicating that the SUP redundancy is working in the Remote PHY configuration.

For more information about SUP redundancy, see Supervisor Redundancy.

DPIC Link Redundancy

The Cisco cBR Series Remote PHY Digital Physical Interface Card (DPIC) provides the Ethernet network connection between the CCAP core and Remote PHY devices.

You can enable or disable RPHY link redundancy feature for a chassis. The redundancy state of a link is described using the link *mode* and *role*.

The redundancy mode is the term that is used for the configured or administered designation of a link, and is determined during the link configuration. The redundancy mode does not change during a switchover. There are two redundancy modes:

- Primary mode: This is the default working link of a core interface. The primary link is fixed to port 0, 2, 4, 6 when the link high availability is enabled.
- Secondary mode: This mode provides protection to the primary link. The secondary link is fixed to port 1, 3, 5, 7 when the link high availability is enabled.

The redundancy role is a dynamic entity that indicates the runtime or operational status of a port. The role changes only during a link switchover. The entity has two states:

- Active role: This link carries the RPHY data stream of the core interface. When the primary link is switched over to the secondary link, the secondary link becomes the active link of the core interface.
- Standby role: This link does not run any RPHY data traffic, but gets prepared to become active when the current active link has failed. According to the physical state of the standby link, the standby link can be further distinguished into a standby-hot link and standby-cold link. A standby-hot retains the link in the UP state. The 10-Gigabit Ethernet transceiver and TX power are enabled in this case, and the 10-Gigabit Ethernet port state is UP in the directly connected switch or router. The link of standby port is shut down, the TX power turned off and the 10-Gigabit Ethernet port state in the directly connected switch or router is down.

cBR supports both standby-hot and standby-cold redundancy modes.

In 1+1 core link redundancy configuration, the secondary link is the backup link for the primary link. At any given time, only one link (the active link) carries the RPHY control and data traffic for a core interface. The standby link provides protection for only one primary link. Current 8x10G DPIC has eight 10G ports on front panel and 4x10G XFI ports to Cylons-R 40G. Each 10G XFI port provides two core interfaces sharing the total 10G bandwidth. For an 8-port DPIC card, you can provide four 1+1 redundant groups.

When link high availability is enabled in the chassis, the secondary card supports link HA as do the other linecards. Each linecard makes its link switchover decisions that is independently based on the physical link state.

How to Configure Remote PHY Line Card Redundancy

This section describes how to configure Remote PHY (R-PHY) Line Card Redundancy on Cisco cBR-8.

Configuring DPIC Ports

Note Sub-interfaces are not supported for DPIC interfaces on linecards in slots 0-3 and 6-9.

The following example shows how to configure DPIC port to support Remote PHY Line Card Redundancy:

```
Router# configure terminal
Router(config)# interface TenGigabitEthernet8/1/0
Router(config-if)# vrf forwarding te80
Router(config-if)# ip address 80.6.16.166 255.255.255.0
Router(config-if)# ip mtu 1500
Router(config-if)# exit
Router(config)# interface TenGigabitEthernet8/1/1
Router(config-if)# vrf forwarding te81
Router(config-if)# ip address 80.6.16.167 255.255.255.0
Router(config-if)# ip mtu 1500
Router(config-if)# exit
Router(config)# interface TenGigabitEthernet6/1/0
Router(config-if)# vrf forwarding te60
Router(config-if)# ip address 80.6.16.186 255.255.255.0
Router(config-if)# ip mtu 1500
Router(config-if)# exit
Router(config)# interface TenGigabitEthernet6/1/1
Router(config-if)# vrf forwarding te61
Router(config-if)# ip address 80.6.16.187 255.255.255.0
Router(config-if)# ip mtu 1500
```

Configuring RPD

The following example shows how to configure RPD to support Remote PHY Line Card Redundancy:

```
Router# configure terminal
Router(config)# cable rpd node1
Router(config-rpd)# identifier 0004.9f03.0055
Router(config-rpd)# core-interface te8/1/0
Router(config-rpd-core)# principal
Router(config-rpd-core)# rpd-ds 0 downstream-cable 8/1/0 profile 0
Router(config-rpd-core)# rpd-us 0 upstream-cable 8/1/0 profile 0
Router(config-rpd-core)# exit
Router(config-rpd)# core-interface te8/1/1
Router(config-rpd-core)# rpd-ds 0 downstream-cable 8/1/1 profile 0
Router(config-rpd-core)# rpd-us 0 upstream-cable 8/1/1 profile 0
Router(config-rpd-core)# exit
Router(config-rpd)# exit
Router(config)# cable rpd node2
Router(config-rpd)# identifier 0004.9f03.0163
Router(config-rpd)# core-interface te8/1/2
Router(config-rpd-core)# principal
Router(config-rpd-core)# rpd-ds 0 downstream-cable 8/0/1 profile 1
Router(config-rpd-core)# rpd-us 0 upstream-cable 8/0/2 profile 2
```

Configuring Remote PHY Line Card Redundancy

The following example shows how to configure Remote PHY Line Card Redundancy:

```
Router# configure terminal
Router(config)# redundancy
Router(config-red)# mode sso
Router(config-red)# linecard-group 0 internal-switch
Router(config-red-lc)# class 1:N
Router(config-red-lc)# member slot 8 primary
Router(config-red-lc)# member slot 6 secondary
Router(config-red-lc)# no revertive
```

Verifying Remote PHY Line Card Redundancy Configuration

To verify the Remote PHY line card redundancy configuration, use the example below:

```
Router# show redundancy linecard all
              LC     My         Peer        Peer      Peer
Slot Subslot  Group  State      State       Slot      Subslot  Role     Mode
-------------------------------------------------------------------------------
 8   -        0      Active     Stdby Warm  6         -        Active   Primary
 6   -        0      -          -           Multiple  None     Standby  Secondary

Router# show cable rpd lcha-cores
MAC Address     IP Address       I/F       State           Core Role  HA Role
0004.9f03.0055  80.6.16.15       Te6/1/0   online          Principal  Standby
0004.9f03.0055  80.6.16.15       Te8/1/0   online          Principal  Active
0004.9f03.0163  80.6.16.16       Te6/1/1   online          Principal  Standby
0004.9f03.0163  80.6.16.16       Te8/1/1   online          Principal  Active

Router# show cable rpd
MAC Address     IP Address       I/F       State           Core Role  HA Role
0004.9f03.0055  80.6.16.15       Te6/1/0   online          Principal  Active
0004.9f03.0163  80.6.16.16       Te6/1/1   online          Principal  Active
```

How to Configure DPIC Link Redundancy

This section describes how to configure DPIC Link Redundancy on Cisco cBR-8.

Configuring DPIC Link Redundancy

The link redundancy is disabled by default. You need to enable the link redundancy feature manually.

- To set the DPIC link in the UP state, use the **cable rphy link redundancy hot** command.
- To set the DPIC link in the standby-down state, use the **cable rphy link redundancy cold** command. For example:

```
Router# cable rphy link redundancy cold

RPHY Link HA: Cold mode enabled
Core Interface  Port  Mode        Role      Status
--------------  ----  ----------  --------  ------
Te 2/1/0        0     Primary     Active    Up
Te 2/1/0        1     Secondary   Standby   Ready
Te 2/1/2        2     Primary     Active    Up
Te 2/1/2        3     Secondary   Standby   Ready
```

```
Te 2/1/4        4     Primary     Active    Up
Te 2/1/4        5     Secondary   Standby   Ready
Te 2/1/6        6     Primary     Active    Up
Te 2/1/6        7     Secondary   Standby   Ready
```

- To disable the link redundancy, run the **no cable rphy link redundancy** command.

Verifying DPIC Link Redundancy

To verify the DPIC link redundancy, go through the following steps:

- To check the link redundancy of any of the DPIC slots, run the **show redundancy digi-pic slot <0-9>** command. See the following example:

```
Router# show redundancy digi-pic slot 0:


RPHY Link HA: Hot mode enabled
Core Interface Port Mode          Role       Status
-------------- ---- --------- ------- ---------------
Te 0/1/0        0    Primary       Active      Up
Te 0/1/0        1    Secondary     Standby     Up (“Ready” in standby-cold mode)
Te 0/1/2        2    Primary       Active      Up
Te 0/1/2        3    Secondary     Standby     Down
Te 0/1/4        4    Primary       Standby     Up (“Ready” in standby-cold mode)
Te 0/1/4        5    Secondary     Active      Up
Te 0/1/6        6    Primary       Active      Down
Te 0/1/6        7    Secondary     Standby     Down
```

- To view the DPIC history, use the **show redundancy digi-pic history slot <0-9>** command. See the following example:

```
Router# show redundancy digi-pic history slot 2

Jun 25 2018 14:41:14 - 2/1/0: Auto switchover from port:1 link:down to port:0 link up,
 success.
Jun 25 2018 14:40:54 - 2/1/0: Auto switchover from port:0 link:down to port:1 link up,
 success.
Jun 25 2018 14:39:20 - 2/1/0: Enable LINKHA success.
Jun 25 2018 14:39:20 - 2/1/2: Enable LINKHA success.
Jun 25 2018 14:39:20 - 2/1/4: Enable LINKHA success.
Jun 25 2018 14:39:20 - 2/1/6: Enable LINKHA success.
Jun 25 2018 14:38:56 - 2/1/0: Disable LINKHA success.
Jun 25 2018 14:38:56 - 2/1/2: Disable LINKHA success.
Jun 25 2018 14:38:56 - 2/1/4: Disable LINKHA success.
Jun 25 2018 14:38:56 - 2/1/6: Disable LINKHA success.
Jun 25 2018 14:37:20 - 2/1/0: Manual switchover from port:1 to port:0, success.
Jun 25 2018 14:37:16 - 2/1/0: Manual switchover from port:0 to port:1, success.
Jun 25 2018 14:36:31 - 2/1/0: Enable LINKHA success.
Jun 25 2018 14:36:31 - 2/1/2: Enable LINKHA success.
Jun 25 2018 14:36:31 - 2/1/4: Enable LINKHA success.
Jun 25 2018 14:36:31 - 2/1/6: Enable LINKHA success.
```

- To check the link redundancy of the TenGigabitEthernet 0/1/4, use the **show redundancy digi-pic interface TenGigabitEthernet 0/1/4** command. See the following example:

```
Router# show redundancy digi-pic interface TenGigabitEthernet 0/1/4

Link HA   : Hot mode enabled
HA State  : In Failover
Reason    : Manual Switchover
```

```
Port Mode      Role        Status
---- --------- ------- -----------
  4  Primary     Standby     Up ("Ready" in standby-cold mode)
  5  Secondary   Active      Up
```

You can view the DPIC history of the TenGigabitEthernet using the **show redundancy digi-pic history interface TenGigabitEthernet <0-9>/1/<0, 2, 4, 6>** command. See the following example:

```
Router# show redundancy digi-pic history interface TenGigabitEthernet 2/1/0

Jun 25 2018 14:41:14 - 2/1/0: Auto switchover from port:1 link:down to port:0 link up,
 success.
Jun 25 2018 14:40:54 - 2/1/0: Auto switchover from port:0 link:down to port:1 link up,
 success.
Jun 25 2018 14:39:20 - 2/1/0: Enable LINKHA success.
Jun 25 2018 14:38:56 - 2/1/0: Disable LINKHA success.
Jun 25 2018 14:37:20 - 2/1/0: Manual switchover from port:1 to port:0, success.
Jun 25 2018 14:37:16 - 2/1/0: Manual switchover from port:0 to port:1, success.
Jun 25 2018 14:36:31 - 2/1/0: Enable LINKHA success.
Jun 25 2018 14:36:02 - 2/1/0: Disable LINKHA success.
Jun 22 2018 00:01:24 - 2/1/0: Enable LINKHA success.
Jun 22 2018 00:00:12 - 2/1/0: Enable LINKHA success.
Jun 22 2018 00:00:08 - 2/1/0: Disable LINKHA success.
Jun 21 2018 23:59:21 - 2/1/0: Enable LINKHA success.
Jun 21 2018 23:52:21 - 2/1/0: Enable LINKHA success.
Jun 21 2018 23:50:21 - 2/1/0: Enable LINKHA success.
Jun 21 2018 23:50:17 - 2/1/0: Disable LINKHA success.
Jun 21 2018 23:43:30 - 2/1/0: Enable LINKHA success.
Jun 21 2018 23:42:02 - 2/1/0: Enable LINKHA success.
Jun 21 2018 23:41:53 - 2/1/0: Disable LINKHA success.
Jun 21 2018 20:43:05 - 2/1/0: Enable LINKHA success.
```

Feature Information for Remote PHY Redundancy

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

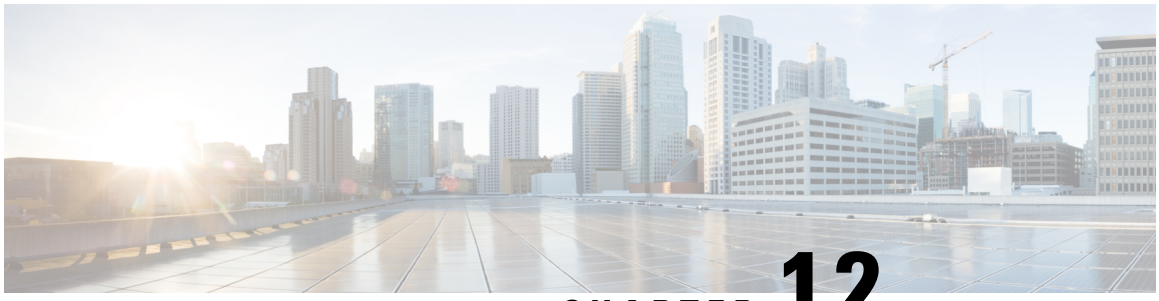
Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 21: Feature Information for Remote PHY Redundancy

Feature Name	Releases	Feature Information
Remote PHY LCHA	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.
Remote PHY SUPHA	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.
DPIC Link Redundancy	Cisco 1x2 / Compact Shelf RPD Software 5.1	This feature was integrated into the Cisco Remote PHY Device.

PART III

Remote PHY System Configuration



CHAPTER 12

Cisco Remote PHY Controller Profile and RPD Configuration

The Remote PHY (R-PHY) Controller Profile includes upstream controller-profile and downstream controller-profile. Upstream controller-profile is used to specify the upstream (US) channels and related parameters, which are part of a specific profile, similar to the following:

- Channel width
- DOCSIS mode
- Frequency
- Minislot size
- Modulation-profile

The downstream controller-profile is used to specify the RF channels and their RF parameters that belong to a specific profile, including the following details:

- Channel type (DOCSIS, Video Sync, Video Async)
- Frequency
- RF output
- QAM-profile (annex, modulation, inter-leaver, symbol rate, and so on)

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 22: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Controller Profile and RPD

The Controller Profile functions in a similar way to the controller integrated-cable Slot/Bay/Port (for downstream controller) or upstream-cable Slot/Bay/Port (for upstream controller) in I-CMTS. However if a Controller Profile is not associated to an RPD, physical resources cannot be allocated.

You can either unicast or multicast this profile. Multicast profile is used for DS sharing. You can multicast the same traffic to all RPDs in the multicast group, or to applications such as switched digital video (SDV) or BC video.

An R-PHY configuration consists of one principal core interface and one auxiliary core interface. The principal core specifies the DPIC interface to which the RPD connects. Auxiliary core interfaces specify the external DPIC interfaces that can be used for downstream sharing. Auxiliary core is used in this release only for video multicast and video OOB.

Configuring Controller Profile and cable RPD are the prerequisites for configuring R-PHY video.

The following table lists the DSCP value for different kinds of items.

Item	Per-Hop-Behavior (PHB)	DSCP Value
DOCSIS data (L2TP)	Best Effort	0
PTP	EF	46
GCP	Best Effort	0
MAP/UCD (L2TP, DOCSIS control)	EF	46
BWR and RNG-REG	EF	46
Video	CS4	32
MDD (L2TP, DOCSIS control), voice	CS5	40

RPD Configurations

Compared to the iCMTS configuration, R-PHY configuration supports the following features:

- Up to 512 RPDs per CBR-8 chassis and 64 RPDs per CBR-CCAP-LC-40G-R line card
- 128 separate service groups per CBR-8 chassis
- 32 downstream controllers and up to 768 downstream channels per CBR-CCAP-LC-40G-R line card
- Up to 158 downstream channels (0-157) per downstream controller
- 64 upstream controllers and 128 upstream channels per CBR-CCAP-LC-40G-R line card

Note Although 128 maximum upstream SCQAM channels per CBR-CCAP-LC-40G-R line card could be configured, but the upstream maximum throughput per CBR-CCAP-LC-40G-R line card is 3Gbps which is due to USJIB limitation. So the upstream service could not be guaranteed when upper than 3Gbps upstream throughput per CBR-CCAP-LC-40G-R line card.

In the R-PHY configuration, the following mapping relationships are supported between the controller and the port on RPD:

- Downstream 1:N (N>= 2) mapping: one DS controller is shared by several RPDs and one DS controller is mapped to one DS port of all these RPDs, that is “DS virtual split”, all these DS ports share the same signals from the same DS controller.
- Downstream N:1 mapping: several DS controllers are mapped into the same DS port of one RPD. Notice: the DS channels in these DS controller should use different rf-channel numbers
- Downstream N:N mapping: mixed 1:N and N:1 mapping. For example: several DS controllers are mapped into one DS port of one RPD. But at the same time they are “virtual split” DS controllers and are shared by several RPDs.
- Upstream 1:1 mapping: one US controller is only mapped to one US port on one RPD. Currently max two US ports are supported on RPD, and for each port, we could configure one US controller.

Note Downstream 1:1 mapping is not supported under 512 RPD configuration, but still supported under smaller scale configuration.

Prerequisites for Configuring Controller Profile and RPD

The following restrictions are applicable to configuring controller profiles:

- All channels within the profiles of an RPD must be unique. Frequencies must not overlap each other.
- The principal core must contain at least one DOCSIS downstream profile
- Auxiliary core should contain only video and out-of-band profiles
- A DS controller can be associated to only one profile

Restrictions for Configuring Controller Profile and RPD

The following restrictions are applicable to configuring upstream controller profiles:

- Legacy controller configuration commands are not supported
- Legacy controller configuration cannot be shown in running-configuration

Configure Controller Profile and RPD

Note To know more about the commands referenced in this module, see the Cisco IOS Master Command List.

Configure Upstream Controller Profile

To configure the upstream controller-profile, use the cable upstream controller-profile command, as given in the following example:

```
Router#cable upstream controller-profile 4
  cable def-phy-burst 0
  us-channel 0 chan-class-id 0
  us-channel 0 channel-width 1600000 1600000
  us-channel 0 docsis-mode atdma
  us-channel 0 equalization-coefficient
  us-channel 0 frequency 50000000
  us-channel 0 hop-priority frequency modulation channel-width
  us-channel 0 ingress-noise-cancellation 100
  us-channel 0 maintain-psd
  us-channel 0 max-logical-chans 1
  us-channel 0 minislot-size 4
  us-channel 0 modulation-profile 221
  us-channel 0 power-level 0
  us-channel 0 rng-holdoff 0
  us-channel 0 shutdown
  us-channel 0 specsvl error-adaptive-profile 1
  us-channel 0 threshold cnr-profiles 25 13
  us-channel 0 threshold corr-fec 3
  us-channel 0 threshold hysteresis 3
  us-channel 0 threshold snr-profiles 25 13
  us-channel 0 threshold uncorr-fec 1
  ...
  end
```

Verify Upstream Controller Profile Configuration

To verify the Upstream controller profile configuration, use the **show cable downstream controller-profile** command or **show running-config | section upstream controller-profile** <*ID*> command, as shown in the following example:

```
Router#show cable upstream controller-profile 0
Load for five secs: 2%/0%; one minute: 3%; five minutes: 3%
Time source is NTP, 15:14:27.916 CST Fri Feb 24 2017

Upstream controller-profile 0
Description:
Upstream controller-profile 0 is being used by controller Upstream-Cable:
8/0/1,  8/0/0
  Controller Upstream-Cable
    ...
  Upstream-channel 0
    chan-class-id                  : 0x0
    channel-width                  : 1600000 1600000
    docsis-mode                    : atdma
    ...
```

Example for the **show running-config | section upstream controller-profile <ID>** command

```
Router#show running-config | s cable upstream controller-profile 0
cable upstream controller-profile 0
 us-channel 0 channel-width 1600000 1600000
 us-channel 0 docsis-mode atdma
 us-channel 0 equalization-coefficient
 us-channel 0 frequency 6000000
 us-channel 0 minislot-size 4
 us-channel 0 modulation-profile 221
 no us-channel 0 shutdown
 us-channel 1 channel-width 1600000 1600000
 us-channel 1 docsis-mode atdma
 us-channel 1 equalization-coefficient
 us-channel 1 frequency 7600000
 us-channel 1 minislot-size 4
```

```
 us-channel 1 modulation-profile 221
 no us-channel 1 shutdown
 us-channel 2 channel-width 1600000 1600000
 us-channel 2 docsis-mode atdma
 us-channel 2 equalization-coefficient
 us-channel 2 frequency 9200000
 us-channel 2 minislot-size 4
 us-channel 2 modulation-profile 221
 no us-channel 2 shutdown
 us-channel 3 channel-width 1600000 1600000
 us-channel 3 docsis-mode atdma
 us-channel 3 equalization-coefficient
 us-channel 3 frequency 10800000
 us-channel 3 minislot-size 4
 us-channel 3 modulation-profile 221
 no us-channel 3 shutdown
 us-channel 4 channel-width 1600000 1600000
 us-channel 4 docsis-mode atdma
 us-channel 4 frequency 12400000
 us-channel 4 minislot-size 4
 us-channel 4 modulation-profile 221
 no us-channel 4 shutdown
 us-channel 5 channel-width 1600000 1600000
 us-channel 5 docsis-mode atdma
 us-channel 5 frequency 14000000
 us-channel 5 minislot-size 4
 us-channel 5 modulation-profile 221
```

Configure RPD for US Controller Profile

To configure RPD for associating an upstream controller-profile, using the **rpd-ds** <*port-id*> **Upstream-Cable** <*slot/sub-slot/controller*> *[profile <id>]* command, as given in the following example:

```
Router#cable rpd 1
 identifier 0004.9f00.0743
 core-interface Te8/1/0
  principal
  rpd-us 0 upstream-cable 8/0/0 profile 0
  rpd-us 1 upstream-cable 8/0/1 profile 4
 r-dti 11
 rpd-event profile 0
---
end
```

The Remote PHY (R-PHY) Controller Profile now provides a new summary that displays the Per RPD us port description. The summary helps distinguish between the different controllers that share the same description of us-channels.

For example, the **show cable modem rpd all summary** command displays the following information:

```
Router#show cable modem rpd all summary

Load for five secs: 5%/0%; one minute: 5%; five minutes: 5%
No time source, *15:36:49.777 UTC Thu Mar 8 2018

RPD ID: badb.ad13.417c
Interface                    Cable Modem                                  Description
          Total Reg Oper  Unreg Offline Wideband initRC initD initIO initO
C9/0/4/U0  1     0   0     1     0       0        1      0     0      0  badb.ad13.417c us
 0
C9/0/4/U1  2     0   0     2     0       0        2      0     0      0  badb.ad13.417c us
 0
C9/0/4/U3  1     0   0     1     0       0        1      0     0      0  badb.ad13.417c us
```

```
 0
C9/0/5/U0  2     0   0     2     0       0        2      0     0      0  badb.ad13.417c us
 1
C9/0/5/U1  1     0   0     1     0       0        1      0     0      0  badb.ad13.417c us
 1

RPD ID: badb.ad13.41fa
Interface                      Cable Modem                                    Description
          Total Reg   Oper  Unreg Offline Wideband initRC initD initIO initO
C9/0/2/U0  2     0     0     2     0       1        1      0     0      1  badb.ad13.41fa
us 0
C9/0/2/U1  1     0     0     1     0       0        1      0     0      0  badb.ad13.41fa
us 0
C9/0/2/U3  1     0     0     1     0       0        1      0     0      0  badb.ad13.41fa
us 0
C9/0/3/U1  1     0     0     1     0       0        1      0     0      0  badb.ad13.41fa
us 1
C9/0/3/U2  2     0     0     2     0       0        2      0     0      0  badb.ad13.41fa
us 1
C9/0/3/U3  1     0     0     1     0       0        1      0     0      0  badb.ad13.41fa
us 1
```

Note The length of configurable limitation is 20 characters while there are 80 characters reserved.

Configure Downstream Controller Profile

To configure downstream controller profile, use the following commands:

```
configure terminal
cable downstream controller-profile <profile ID>
multicast-pool <id>
rf-chan 20 47
type video <SYNC | ASYNC>
frequency 231000000
rf-output NORMAL
qam-profile <profile ID>
```

The *multicast-pool <id>* defines the DEPI multicast group. The type video *<SYNC | ASYNC>* defines synchronous or asynchronous mode.

Verify Downstream Controller Profile Configuration

To verify the Downstream controller profile configuration, use the show cable downstream controller-profile command as shown in the following example:

```
Router#show running-config | section downstream controller-profile
cable downstream controller-profile 0
 rf-chan 0 3
  type DOCSIS
  frequency 111000000
  rf-output NORMAL
  qam-profile 1
  docsis-channel-id 1
```

Configure RPD for DS Controller Profile

To configure RPD for associating a downstream controller-profile, use the following commands:

```
configure terminal
cable rpd RPD01
identifier 0004.9f31.0435
core-interface Te3/1/0
principal
rpd-ds 0 downstream-cable 3/0/0 profile 1
rpd-ds 0 downstream-cable 3/0/1 profile 2
rpd-us 0 upstream-cable 3/0/0 profile 1
core-interface te6/1/0
rpd-ds 0 downstream-cable 6/0/0 profile 2
r-dti 1
rpd-event profile 0
```

The **rpd-ds** *0* **downstream-cable** *3/0/0 profile 1* associates *controller 3/0/0* with *profile 1*, which is a DOCSIS profile.

The **rpd-ds** *0* **downstream-cable** *3/0/1 profile 2* associates *controller 3/0/1* with *profile 3*, which is a video profile.

The *core-interface te6/1/0* defines an auxiliary interface for this RPD. This auxiliary interface is used to configure downstream sharing across line cards.

Verify RPD Association with Controller Profile

To verify the downstream controller profile association with RPD, use the **show running-config | section cable rpd <ID>** command as shown in the following example:

```
Router#show running-config | section cable rpd RPD01
cable rpd toi-test1
 identifier 0000.1cbf.0000
 core-interface Te2/1/0
  principal
  rpd-ds 0 downstream-cable 2/0/9 profile 0
 rpd-event profile 0
```

Configure Downstream Video Controller Profile

To configure a downstream video controller profile, use the following commands:

```
cable downstream controller-profile <profile ID> Video
max-carrier <RF Port Max Carrier Value>
rf-chan <Starting QAM ID> <Ending QAM ID>
  type VIDEO <SYNC | ASYNC>
  qam-profile <profile id>
  frequency 453000000
  rf-output NORMAL
```

Configure RPD for Downstream Video Controller Profile

To configure RPD for associating a downstream video controller-profile, use the following commands:

```
cable rpd RPD01
identifier 0053.ad17.5c80
core-interface Te1/1/0
  principal
```

```
  rpd-ds 0 downstream-cable 1/0/0 profile 7
  rpd-ds 0 downstream-video 1/0/0 profile 100
  rpd-us 0 upstream-cable 1/0/1 profile 3
r-dti 7
rpd-event profile 0
rpd-55d1-us-event profile 0
```

The **rpd-ds** *0* **downstream-cable** *1/0/0 profile 7* associates *controller 1/0/0* with *profile 7*, which is a DOCSIS profile.

The **rpd-ds** *0* **downstream-video** *1/0/0 profile 100* associates *controller 1/0/0* with *profile 100*, which is a video profile.

Note

- The **rpd-ds downstream-video** command is available from Cisco IOS XE Gibraltar 16.12.1 release and Cisco IOS XE Amsterdam 17.3.1x release. Using this command, you can create up to 32 separate video service groups on the Kobol-R line card.
- We recommend using **rpd-ds downstream-video** command for video channels and **rpd-ds downstream-cable** command for DOCSIS channels.
- We do not recommend using **downstream-cable** controllers for video and DOCSIS channels simultaneously. Use **downstream-video** controllers for video channels.

Configure Downstream Sharing

This configuration is optional. DS sharing is used for multicast (MC) traffic. To configure downstream sharing, use the following commands:

```
configure terminal
cable rpd RPD01
core-interface Te3/1/0
principal
rpd-ds 0 downstream-cable 3/0/1 profile 2
cable rpd RPD02
core-interface te3/1/0
principal
rpd-ds 0 downstream-cable 3/0/1 profile 2
```

Note All RDPs in the same multicast group should have the same controller and profile association.

Configure Controller in Fiber Node

To configure the controllers in fiber-node, use the **cable fiber-node** command, as given in the following example:

```
cable fiber-node 113
 downstream Downstream-Cable 8/0/0
 upstream Upstream-Cable 8/0/1
```

Verify CM RPD Association

To verify the RPD associated with the cable modem, use the **show cable modem rpd** command as shown in the following example:

```
Router# show cable modem rpd 0004.9f03.0249
Load for five secs: 4%/2%; one minute: 3%; five minutes: 4%
Time source is NTP, 10:48:11.763 CST Tue Feb 28 2017
                                                                                D
MAC Address    IP Address      I/F           MAC               Prim  RxPwr  Timing Num I
                                             State             Sid   (dBmv) Offset CPE P
0023.be5a.bb6c 10.10.10.12     C6/0/0/UB     w-online          5     0.00   862    0   N
1859.3356.8876 10.10.10.13     C6/0/0/UB     w-online          6     0.50   907    0   N
```

Display GCP Ralated Information

To display Generic Control Plane (GCP) related information of the RPD, use the command as shown in the following example:

```
Router#show cable rpd 0004.9f03.0280 Te3/1/0 gcp-state

MAC Address     IP Address       I/F       State        Role HA  Name
0004.9f03.0280  10.10.10.11      Te3/1/0   ready        Pri  Act 2

A06#show cable rpd 0004.9f03.0280 Te3/1/0 gcp-state
MAC Address     IP Address       I/F       State        Role HA  Name
0004.9f03.0280  10.10.10.11      Te3/1/0   ready        Pri  Act 2

Router#show cable rpd name node te1/1/0 gcp-session

GCP Session ID : 10
Core Address   : 10.100.10.11:8190
RPD Address    : 10.10.10.11:60656
Next Hop MAC   : 0004.9F00.0901
Session State  : Active

Packet Statistics:
========================
Rx         : 5038
Tx         : 5034
Rx Dropped : 0
Tx Dropped : 0

Message Statistics:
========================
Rx         : 5948
Tx         : 5954
Rx Dropped : 7
Tx Dropped : 0
Rx Illegal : 0
Tx Illegal : 0

Router#show cable rpd 120.102.6.7 te9/1/1 gcp-transaction
 Load for five secs: 3%/1%; one minute: 4%; five minutes: 4%
No time source, *10:22:57.158 CST Thu Mar 16 2017

RPD ID           I/F        TRANS ID   GCP MSG TYPE             RCP MSG TYPE   TIMESTAMP
---------------- ---------- ---------- ------------------------ --------------
-------------------------
0004.9f31.1007   Te9/1/1    7452       GCP_MSG_ID_EDS_RSP       TYPE_REX       2017-03-16
10:22:54.440
```

```
0004.9f31.1007   Te9/1/1    7452       GCP_MSG_ID_EDS           TYPE_REX       2017-03-16
10:22:54.415
0004.9f31.1007   Te9/1/1    7451       GCP_MSG_ID_EDS_RSP       TYPE_REX       2017-03-16
10:22:54.240
0004.9f31.1007   Te9/1/1    7451       GCP_MSG_ID_EDS           TYPE_REX       2017-03-16
10:22:54.215
0004.9f31.1007   Te9/1/1    7450       GCP_MSG_ID_EDS_RSP       TYPE_REX       2017-03-16
10:22:54.040
0004.9f31.1007   Te9/1/1    7450       GCP_MSG_ID_EDS           TYPE_REX       2017-03-16
10:22:54.015
0004.9f31.1007   Te9/1/1    7449       GCP_MSG_ID_EDS_RSP       TYPE_REX       2017-03-16
10:22:53.836
0004.9f31.1007   Te9/1/1    7449       GCP_MSG_ID_EDS           TYPE_REX       2017-03-16
10:22:53.815
0004.9f31.1007   Te9/1/1    7448       GCP_MSG_ID_EDS_RSP       TYPE_REX       2017-03-16
10:22:50.236
0004.9f31.1007   Te9/1/1    7448       GCP_MSG_ID_EDS           TYPE_REX       2017-03-16
10:22:50.215
0004.9f31.1007   Te9/1/1    7447       GCP_MSG_ID_EDS_RSP       TYPE_REX       2017-03-16
10:22:50.038
0004.9f31.1007   Te9/1/1    7447       GCP_MSG_ID_EDS           TYPE_REX       2017-03-16
10:22:50.015
0004.9f31.1007   Te9/1/1    7446       GCP_MSG_ID_EDS_RSP       TYPE_REX       2017-03-16
10:22:49.839
0004.9f31.1007   Te9/1/1    7446       GCP_MSG_ID_EDS           TYPE_REX       2017-03-16
10:22:49.815
```

Display DEPI Ralated Information

To display the Downstream External PHY Interface (DEPI) related information, use the command as shown in the following example:

```
Router#show cable rpd depi

DEPI Tunnel and Session Information Total tunnels 1 sessions 26
LocTunID   RemTunID   Remote Device  State  Remote Address  Sessn L2TP Class
                                                           Count
338514820  671581873  0004.9f00.0901 est    10.10.10.11     26    rphy-l2tp-gl...

LocID      RemID      Pseudowire      State  Last Chg Uniq ID    Type Mode RemSt
0x41040008 0x00000B02 US1/0/0:2(R)    est    00:34:57 21          P    PSP  UP
0x41010000 0x00000600 US1/0/0:0(D)    est    00:34:57 11          P    PSP  UP
0x00002006 0x00000405 DS1/0/0:5       est    00:34:57 6           P    PSP  UP
0x00002004 0x00000403 DS1/0/0:3       est    00:34:57 4           P    PSP  UP
0x4100000C 0x00000D03 US1/0/0:3(M)    est    00:34:57 23          P    PSP  UP
0x00002002 0x00000401 DS1/0/0:1       est    00:34:57 2           P    PSP  UP
0x00002007 0x00000406 DS1/0/0:6       est    00:34:57 7           P    PSP  UP
0x00002008 0x00000407 DS1/0/0:7       est    00:34:57 8           P    PSP  UP
0x4101000C 0x00000603 US1/0/0:3(D)    est    00:34:57 24          P    PSP  UP
0x41000004 0x00000D01 US1/0/0:1(M)    est    00:34:57 15          P    PSP  UP
0x00002001 0x00000400 DS1/0/0:0       est    00:34:57 1           P    PSP  UP
0x41080008 0x00000F02 US1/0/0:2(S)    est    00:34:57 22          P    PSP  UP
0x41010004 0x00000601 US1/0/0:1(D)    est    00:34:57 16          P    PSP  UP
0x41020000 0x00000800 US1/0/0:0(B)    est    00:34:57 12          P    PSP  UP
0x00002009 0x00000408 DS1/0/0:8       est    00:34:57 9           P    PSP  UP
0x41010008 0x00000602 US1/0/0:2(D)    est    00:34:57 20          P    PSP  UP
0x41000008 0x00000D02 US1/0/0:2(M)    est    00:34:57 19          P    PSP  UP
0x4108000C 0x00000F03 US1/0/0:3(S)    est    00:34:57 26          P    PSP  UP
0x00002003 0x00000402 DS1/0/0:2       est    00:34:57 3           P    PSP  UP
0x41080000 0x00000F00 US1/0/0:0(S)    est    00:34:57 14          P    PSP  UP
0x41040004 0x00000B01 US1/0/0:1(R)    est    00:34:57 17          P    PSP  UP
0x41080004 0x00000F01 US1/0/0:1(S)    est    00:34:57 18          P    PSP  UP
```

```
0x41000000 0x00000D00 US1/0/0:0(M)    est    00:34:56 10         P    PSP  UP
0x00002005 0x00000404 DS1/0/0:4       est    00:34:56 5          P    PSP  UP
0x4104000C 0x00000B03 US1/0/0:3(R)    est    00:34:56 25         P    PSP  UP
0x41040000 0x00000B00 US1/0/0:0(R)    est    00:34:56 13         P    PSP  UP

outer#show cable rpd 0004.9f03.0214 te7/1/0 depi tunnel

Load for five secs: 7%/2%; one minute: 6%; five minutes: 6%
No time source, *12:41:44.228 CST Mon Mar 20 2017

LocTunID   RemTunID   Remote Device  State  Remote Address  Sessn L2TP Class
                                                           Count
3388764998 1054297851 0004.9f03.0214 est    10.10.10.11     29    rphy-l2tp-gl...
```

Table 23: show cable rpd depi Field Descriptions

Field	Description
LocID	Local session ID.
RemID	Remote session ID.
US1/0/0:2(R)	US means UEPI session, DS means DEPI session. This string means UEPI session on line card slot 1, controller 0, rf-channel 2.
est in State	Established state.
P in Type	On primary line card.

Troubleshooting Tips

Refer to the following troubleshooting tips if configuration errors occur.

If you configure DS controller profile and cable RPD, you can check the controller status, regardless of the status of the RPD. If the channel's state is DOWN, use verbose option to view the reason.

```
Router#show controllers downstream-Cable 6/0/1 rf-channel 20 <verbose>
Chan State Admin Frequency Type       Annex Mod  srate Interleaver dcid output
20    UP    UP   231000000 VIDEO-SYNC B     256   5361  I128-J1     -   NORMAL
```

Configuration Examples

This section provides example configurations for the R-PHY Controller Profile.

Example: Controller Profile Configuration

Upstream Controller Profile Configuration

```
configure terminal
cable upstream controller-profile 2
  cable def-phy-burst 0
  us-channel 0 chan-class-id 0
  us-channel 0 channel-width 1600000 1600000
  us-channel 0 docsis-mode atdma
```

```
us-channel 0 equalization-coefficient
us-channel 0 frequency 50000000
us-channel 0 hop-priority frequency modulation channel-width
us-channel 0 ingress-noise-cancellation 100
us-channel 0 maintain-psd
us-channel 0 max-logical-chans 1
us-channel 0 minislot-size 4
us-channel 0 modulation-profile 221
us-channel 0 power-level 0
us-channel 0 rng-holdoff 0
us-channel 0 shutdown
us-channel 0 specsvl error-adaptive-profile 1
us-channel 0 threshold cnr-profiles 25 13
us-channel 0 threshold corr-fec 3
us-channel 0 threshold hysteresis 3
us-channel 0 threshold snr-profiles 25 13
us-channel 0 threshold uncorr-fec 1
...
end
```

Downstream Controller Profile Configuration

```
configure terminal
cable downstream controller-profile 1
multicast-pool 20
Rf-channel 0 15
Type docsis
Frequency 111000000
Rf-output NORMAL
Qam-profile 1
Docsis-channel-id 1
cable downstream controller-profile 2
multicast-pool 20
Rf-channel 20 47
Type video sync
Frequency 231000000
Rf-output NORMAL
Qam-profile 14
```

Example: Downstream Sharing Configuration

```
cable rpd RPD01
identifier 0004.9f31.0979
core-interface te6/1/0
principal
rpd-ds 0 downstream-cable 6/0/0 profile 1
rpd-ds 0 downstream-cable 6/0/1 profile 2
rpd-us 0 upstream-cable 6/0/0 profile 1
r-dti 6
rpd-event profile 0
cable rpd RPD2
identifier 0004.9f31.1437
core-interface Te3/1/0
principal
rpd-ds 0 downstream-cable 3/0/0 profile 1
rpd-us 0 upstream-cable 3/0/0 profile 1
core-interface Te6/1/0
rpd-ds 0 downstream-cable 6/0/1 profile 2
r-dti 3
rpd-event profile 0
```

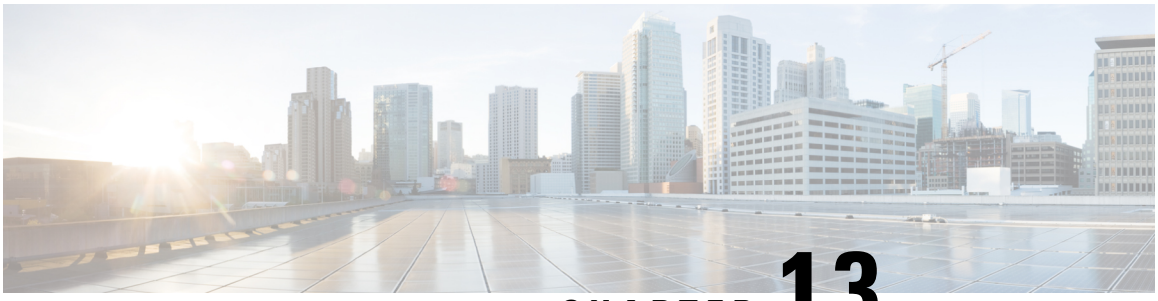
Feature Information for Remote PHY Controller Profile and RPD Configuration

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 www.cisco.com/go/cfn 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 24: Feature Information for Remote PHY Controller Profile and RPD Configuration

Feature Name	Releases	Feature Information
Large Scale Controller Support (32DS/64US) with node	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.
256 RPD Support per Chassis	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.
Controller profile configuration	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.
US 128 channels	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.



CHAPTER 13

Cisco Remote PHY Device Downstream Virtual Splitting

This document provides information on how to configure downstream virtual splitting on Remote PHY systems.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 25: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information about RPD Downstream Virtual Splitting

The primary use case for multicast delivery between CCAP-core and the RPD is for the delivery of broadcast video services from a single CCAP-core element to a number of RPDs. This allows the system to scale by allowing a single CCAP-core element to generate and serve streams to all the RPDs that are configured to receive the same broadcast lineup. Since broadcast serving groups are quite large (~100,000 or more subscribers), using multicast to deliver the same copy to hundreds of remote PHY devices provides significant cost savings for operators. This mechanism can be used for broadcast video delivered via MPEG QAM channels or for that delivered via IP over DOCSIS. It is meant for the replication of an entire QAM channel to multiple RPDs.

Configure RPD Downstream Virtual Splitting

This section describes how to configure RPD Downstream Virtual Splitting on Cisco cBR-8.

Note To know more about the commands referenced in this module, see the Cisco IOS Master Command List.

Configure Multicast DEPI Pool

To configure the multicast DEPI pool, complete the following procedure:

```
configure terminal
cable depi multicast pool id
{ip|ipv6} address ip mask
```

To verify the multicast DEPI pool configuration, use the **show cable depi multicast pool** command as shown in the example below:

```
Router# show cable depi multicast pool
Load for five secs: 4%/0%; one minute: 5%; five minutes: 5%
No time source, *09:23:41.545 CST Mon Apr 23 2018
POOL ID    Net IP           Net Mask         Redundant DESCRIPTION
1          227.0.0.0        255.255.255.0    FALSE
2          228.0.0.0        255.255.254.0    FALSE
127        227.226.225.0    255.255.255.0    FALSE     to TE9/1/1+TE9/1/7

POOL ID    IPv6                                          Redundant DESCRIPTION
6          FF3A::9000:0/126                              FALSE
```

Configure Redundant Multicast DEPI Pool

When a secondary line card is configured, multicast IP addresses are assigned to its downstream controllers from the redundant multicast DEPI pool.

To configure the redundant multicast DEPI pool, complete the following procedure:

```
configure terminal
cable depi multicast pool id
redundant
```

To verify the multicast DEPI pool configuration, use the **show cable depi multicast pool** command as shown in this example:

```
Router# show cable depi multicast pool
Load for five secs: 4%/0%; one minute: 4%; five minutes: 4%
No time source, *14:14:13.780 CST Tue Aug 7 2018
POOL ID    Net IP           Net Mask         Redundant DESCRIPTION
1          227.0.0.0        255.255.0.0      FALSE
127        227.226.225.0    255.255.255.0    FALSE     to TE9/1/1+TE9/1/7

POOL ID    IPv6                                          Redundant DESCRIPTION
2          FF39::8000:0/120                              FALSE
4          FF39::9000:0/112                              TRUE
```

To view the IPv6 addresses assigned to the secondary linecard downstream controllers, use the **show cable depi multicast ipv6 all** command as shown in this example:

```
Router# show cable depi multicast ipv6 all
Load for five secs: 5%/0%; one minute: 5%; five minutes: 4%
No time source, *14:15:08.476 CST Tue Aug 7 2018
IPv6                                          POOL ID    CONTROLLER
FF39::9000:0                                  4          0/0/0(1-Te0/1/0)
FF39::9000:8                                  4          0/0/1(2-Te0/1/0)
FF39::9000:10                                 4          0/0/2(3-Te0/1/0)
FF39::9000:18                                 4          0/0/3(4-Te0/1/0)
FF39::9000:20                                 4          0/0/4(5-Te0/1/0
```

Note

- To view the IPv4 addresses, use the **show cable depi multicast ip all** command.
- One redundant DEPI pool is available for either IPv4 or IPv6 addresses.
- If you do not configure redundant pool, secondary linecard downstream controllers use the same IP as the downstream controllers in the primary linecard.
- You cannot use the redundant multicast pool in the downstream controller profile configuration.

Enable Multicast Sharing under Downstream Controller Profile

To enable the multicast sharing under downstream controller profile, complete the following procedure:

```
configure terminal
cable downstream controller-profile id
multicast-pool id
```

Then configure the other parameters of the controller profile and related RF channels.

Starting from Cisco 1x2 / Compact Shelf RPD Software 3.1, user can change the multicast pool for the downstream sharing controllers without configuring the RPD. See the following example for detailed configuration:

```
Router#config terminal
Router(config)#cable downstream controller-profile 111
Warning: changes to this profile will affect the following controllers:
Downstream controller-profile 111 is being used by controller Downstream-Cable:
         6/0/0,  6/0/1,

Confirm to continue? [no]: yes
Router(config-controller-profile)#multicast-pool 50
This profile is being used by the following RPDs:
Controller RPD DS Port List:
  RPD ID           I/F       Name
  ---------------- --------- ----------------
  0004.9f03.0214   Te6/1/0   rpd_b
  000c.2923.9991   Te6/1/0   rpd_a               ...

Confirm to continue? [no]: yes
```

To verify the multicast sharing is enabled under the downstream controller profile, use the **show cable downstream controller-profile** command as shown in the example below:

```
Router# show cable downstream controller-profile 1
Load for five secs: 8%/1%; one minute: 10%; five minutes: 10%
No time source, *07:14:32.551 CST Tue Nov 15 2016
Downstream controller-profile 1
Description:
Downstream controller-profile 1 is being used by controller Downstream-Cable:
  3/0/0,
  Admin:  UP
  MaxOfdmSpectrum: 0
  MaxCarrier: 128
  BasePower: 33.0 dBmV
  Mode: normal
  Frequency profile: unconfigured
```

```
DS Splitting: Yes
Multicast Pool ID: 1
```

Configure the RPD with the Same Downstream Controller and Profile

To configure the RPDs with the same downstream controller and profile, complete the following procedure:

```
configure terminal
cable rpd name
identifier id
core-interface TenGigabitEthernet slot/subslot/port
principal
rpd-ds 0 downstream-cable slot/subslot/port profile id
rpd-us 0 upstream-cable slot/subslot/port profile id
r-dti id
rpd-event profile id
```

Note Configure at least 2 RPDs with the same downstream controller and profile to implement the multicast DEPI.

Configure the RPDs to different fiber-nodes

To configure the RPDs to different fiber-nodes, complete the following procedure:

```
configure terminal
cable fiber-node id
downstream Downstream-Cable slot/subslot/port
upstream Upstream-Cable slot/subslot/port
```

Note Configure at least 2 fiber-nodes with the same downstream controller to implement the multicast DEPI.

Configure the RPDs to MAC Domain

To configure the RPDs to the MAC domain, complete the following procedure:

```
configure terminal
interface cable slot/subslot/port
downstream Downstream-Cable slot/subslot/port rf-channel id
upstream index Upstream-Cable slot/subslot/port us-channel index
cable upstream index jumbo-grants
cable upstream balance-scheduling
cable upstream bonding-group id
upstream id
attributes 800000F0
cable bundle id
cable map-advance static value
cable sid-cluster-group num-of-cluster value
cable sid-cluster-switching max-request value
```

Note Different RPDs can be configured to share the same downstream controller under one MAC domain or different MAC domains.

Enable Multicast on Cisco cBR-8 Router

To enable the multicast on cBR-8, complete the following procedure:

```
configure terminal
ip multicast-routing distributed
```

Enable Multicast on Layer 2 Switch

To enable multicast on Layer 2 switch, complete the following procedure:

```
configure terminal
ip igmp snooping
vlan configuration vlan
ip igmp snooping querier ip
```

Only need to create IGMP Snooping Group on one switch between DPIC and RPD.

Create IGMP Snooping Group under vlan which is used for connection between DPIC and RPD.

IP address used for IGMP snooping querier can be any address that is not conflict with the existing IP address in the system.

Enable Multicast on Layer 3 Router

To enable multicast on Layer 3 router, complete the following procedure:

```
configure terminal
ip pim ssm default
interface gigabitEthernet 0/0/0
ip pim sparse-dense-mode
ip igmp version 3
```

SSM must be enabled on all routers between DPIC and RPD.

All PIM neighbor must be enabled on all routers.

PIM neighbor can use sparse-dense-mode or sparse-mode.

Verify RPD Downstream Virtual Splitting Configuration on cBR-8 Side

To verify the RPD Downstream Virtual Splitting configuration on cBR-8 side, complete the procedure as shown in the example below, and check if these criteria are met:

- The remote session ID begins with 0x8 in the output of the **show cable rpd depi | in Ds** command.

```
Router# show cable rpd depi | in Ds
0x40003F21 0x80003D22 1377638051 Ds3/0/0:0       est    04:20:36 1          P
0x40003F31 0x80003D32 1377638051 Ds3/0/0:16      est    04:20:35 3          P
```

```
0x40003F41 0x80003D42 1377638051 Ds3/0/0:32      est    04:20:35 5          P
0x40003F39 0x80003D3A 1377638051 Ds3/0/0:24      est    04:20:35 4          P
0x40003F29 0x80003D2A 1377638051 Ds3/0/0:8       est    04:20:34 2          P
0x40103F21 0x80003D22 1404837649 Ds3/0/0:0       est    00:07:21 14         P
0x40103F39 0x80003D3A 1404837649 Ds3/0/0:24      est    00:07:21 17         P
0x40103F41 0x80003D42 1404837649 Ds3/0/0:32      est    00:07:21 18         P
0x40103F29 0x80003D2A 1404837649 Ds3/0/0:8       est    00:07:21 15         P
0x40103F31 0x80003D32 1404837649 Ds3/0/0:16      est    00:07:21 16         P
```

- There is assigned IP and pool ID in the output of the **show cable depi multicast ip all** command.

```
Router# show cable depi multicast ip all
Load for five secs: 7%/2%; one minute: 8%; five minutes: 8%
No time source, *23:00:55.344 CST Sun Nov 13 2016
ASSIGNED IP      POOL ID    CONTROLLER
225.225.225.0    1          3/0/0
```

- The cable modem is online in the output of the **show cable modem rpd** command.

```
Router# show cable modem
Load for five secs: 8%/3%; one minute: 9%; five minutes: 9%
No time source, *16:06:52.191 CST Thu Mar 2 2017

 D
MAC Address    IP Address      I/F           MAC               Prim  RxPwr  Timing Num
 I
                                             State             Sid   (dBmv) Offset CPE
 P
5039.558a.6c1c 40.242.0.17     C7/0/0/U1     online            5     0.50   816    0
 N
5039.558a.754a 40.242.9.201    C7/0/0/U0     online            6     0.00   814    0
 N
5039.558a.754e 40.242.9.207    C7/0/0/U0     online            7     0.00   814    0
 N
5039.558a.6b98 40.242.0.16     C7/0/0/U0     online            8     0.00   817    0
 N
0025.2e34.4380 40.242.62.172   C7/0/1/U1     online            2     0.00   783    0
 N

Router# show cable rpd
Load for five secs: 8%/3%; one minute: 9%; five minutes: 9%
No time source, *16:06:55.706 CST Thu Mar 2 2017

MAC Address     IP Address       I/F       State        Role HA  Name
0004.9f03.0214  120.105.4.7      Te7/1/0   online       Pri  Act rpd_b
000c.2923.9991  120.105.4.6      Te7/1/0   online       Pri  Act rpd_a
000c.2923.9991  120.105.4.6      Te6/1/0   online       Aux  Act rpd_a

Router# show cable modem rpd 0004.9f03.0214
Load for five secs: 8%/3%; one minute: 9%; five minutes: 9%
No time source, *16:07:07.790 CST Thu Mar 2 2017

 D
MAC Address    IP Address      I/F           MAC               Prim  RxPwr  Timing Num
 I
                                             State             Sid   (dBmv) Offset CPE
 P
5039.558a.6c1c 40.242.0.17     C7/0/0/U1     online            5     0.50   816    0
 N
5039.558a.754a 40.242.9.201    C7/0/0/U0     online            6     0.00   814    0
 N
5039.558a.754e 40.242.9.207    C7/0/0/U0     online            7     0.00   814    0
 N
```

Verify RPD Virtual Downstream Splitting Configuration on Node Side

To verify the RPD Downstream Virtual Splitting configuration on node side, complete the procedure on RPD as shown in the example below, and check if these criteria are met:

- All L2TP session ID must be start with 800.

```
RPD# show l2tp session
L2TP Tunnel Information Total tunnels 1 sessions 13
LocSessID RemSessID LocTunID  RemTunID  State Type       Last Chg
80003d22  40103f21  9fef9255  53bc1f11  est   MCM        07:10:54 2016-11-13
80003d2a  40103f29  9fef9255  53bc1f11  est   MCM        07:10:57 2016-11-13
80003d42  40103f41  9fef9255  53bc1f11  est   MCM        07:10:56 2016-11-13
80003d32  40103f31  9fef9255  53bc1f11  est   MCM        07:10:59 2016-11-13
80003d3a  40103f39  9fef9255  53bc1f11  est   MCM        07:10:56 2016-11-13
```

- All downstream DEPI SrcIP must be multicast IP that is the same as cBR-8 side.

```
RPD# show downstream depi configuration
Channel PwSubtype     SessionId  SrcIp
0       MCM           2147499298 225.225.225.0
8       MCM           2147499306 225.225.225.0
16      MCM           2147499314 225.225.225.0
24      MCM           2147499322 225.225.225.0
32      MCM           2147499330 225.225.225.0
```

Example: RPD Downstream Virtual Splitting Configuration

The following example shows how to configure RPD Downstream Virtual Splitting:

```
Router# configure terminal
Router(config)# cable depi multicast pool 1
Router(config-multicast-pool)# ip address 225.225.225.0 255.255.255.0
Router(config-multicast-pool)# exit
Router(config)# cable downstream controller-profile 0
Router(config-controller-profile)# multicast-pool 1
Router(config-controller-profile)# max-carrier 128
Router(config-controller-profile)# base-channel-power 34
Router(config-controller-profile)# rf-chan 0 95
Router (config-prof-rf-chan)# type DOCSIS
Router (config-prof-rf-chan)# frequency 285000000
Router (config-prof-rf-chan)# rf-output NORMAL
Router (config-prof-rf-chan)# qam-profile 1
Router (config-prof-rf-chan)# power-adjust 0
Router (config-prof-rf-chan)# docsis-channel-id 1
Router (config-prof-rf-chan)# end
Router# configure terminal
Router(config)# cable rpd node_1
Router(config-rpd)# identifier 0004.9f03.0214
Router(config-rpd)# core-interface Te9/1/0
Router(config-rpd-core)# principal
Router(config-rpd-core)# rpd-ds 0 downstream-cable 9/0/0 profile 0
Router(config-rpd-core)# rpd-us 0 upstream-cable 9/0/0 profile 221
Router(config-rpd-core)# exit
Router(config-rpd)# r-dti 20
Router(config-rpd)# rpd-event profile 0
Router(config-rpd)# exit
Router(config)# cable rpd node_2
Router(config-rpd)# identifier 000c.2923.9991
Router(config-rpd)# core-interface Te9/1/0
```

```
Router(config-rpd-core)# principal
Router(config-rpd-core)# rpd-ds 0 downstream-cable 9/0/0 profile 0
Router(config-rpd-core)# rpd-us 0 upstream-cable 9/0/1 profile 221
Router(config-rpd-core)# exit
Router(config-rpd)# r-dti 20
Router(config-rpd)# rpd-event profile 0
Router(config-rpd)# exit
Router(config)# cable fiber-node 100
Router(config-fiber-node)# downstream Downstream-Cable 9/0/0
Router(config-fiber-node)# upstream Upstream-Cable 9/0/0
Router(config-fiber-node)# exit
Router(config)# cable fiber-node 101
Router(config-fiber-node)# downstream Downstream-Cable 9/0/0
Router(config-fiber-node)# upstream Upstream-Cable 9/0/1
Router(config-fiber-node)# exit
Router(config)# interface Cable 9/0/0
Router(config-if)# downstream Downstream-Cable 9/0/0 rf-channel 0
Router(config-if)# downstream Downstream-Cable 9/0/0 rf-channel 8
Router(config-if)# upstream 0 Upstream-Cable 9/0/0 us-channel 0
Router(config-if)# upstream 1 Upstream-Cable 9/0/0 us-channel 1
Router(config-if)# upstream 2 Upstream-Cable 9/0/0 us-channel 2
Router(config-if)# upstream 3 Upstream-Cable 9/0/0 us-channel 3
Router(config-if)# upstream 4 Upstream-Cable 9/0/1 us-channel 0
Router(config-if)# upstream 5 Upstream-Cable 9/0/1 us-channel 1
Router(config-if)# upstream 6 Upstream-Cable 9/0/1 us-channel 2
Router(config-if)# upstream 7 Upstream-Cable 9/0/1 us-channel 3
Router(config-if)# cable upstream 0 jumbo-grants
Router(config-if)# cable upstream balance-scheduling
Router(config-if)# cable upstream bonding-group 1
Router(config-upstream-bonding)# upstream 0
Router(config-upstream-bonding)# upstream 1
Router(config-upstream-bonding)# upstream 2
Router(config-upstream-bonding)# upstream 3
Router(config-upstream-bonding)# attributes 800000F0
Router(config-upstream-bonding)# exit
Router(config-if)# cable upstream bonding-group 2
Router(config-upstream-bonding)# upstream 4
Router(config-upstream-bonding)# upstream 5
Router(config-upstream-bonding)# upstream 6
Router(config-upstream-bonding)# upstream 7
Router(config-upstream-bonding)# attributes 8000000F
Router(config-upstream-bonding)# exit
Router(config-if)# cable bundle 1
Router(config-if)# cable map-advance static 1000
Router(config-if)# cable sid-cluster-group num-of-cluster 2
Router(config-if)# cable sid-cluster-switching max-request 2
Router(config-if)# exit
Router(config)# ip multicast-routing distributed
Router(config)# interface TenGigabitEthernet 9/1/0
Router(config-if)# ip address 192.168.3.1 255.255.255.0
Router(config-if)# end
```

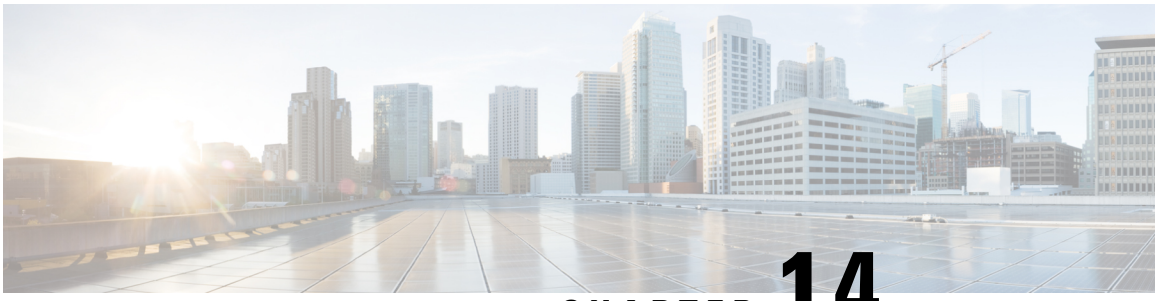
Feature Information for RPD Downstream Virtual Splitting

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

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

Table 26: Feature Information for RPD Downstream Virtual Splitting

Feature Name	Releases	Feature Information
DS virtual splitting	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.



CHAPTER 14

Cisco Remote PHY DS OFDM Channel Configuration

This document provides information on how to configure DOCSIS 3.1 DS OFDM channel on Remote PHY systems.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 27: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information About R-PHY DOCSIS 3.1 DS OFDM Channel

Cisco cBR routers support DS OFDM channels in an R-PHY system. The OFDM-channel-support includes one OFDM channel for each Remote PHY device (RPD) with a channel bandwidth up to 192 MHz and the modulation up to 4096 QAM.

Each OFDM channel supports a control profile, the NCP profile, and up to five data profiles. For a line card, a maximum of 16 DS OFDM channels are supported.

Configure DS OFDM Channel

Note To know more about the commands referenced in this section, see the Cisco IOS Master Command List.

Configure OFDM Channel Profile

To configure the OFDM channel profile, run the following commands:

```
enable
configure terminal

cable downstream ofdm-chan-profile id
  description System Profile id
  cyclic-prefix value
  interleaver-depth value
  pilot-scaling value
  roll-off value
  subcarrier-spacing value
  profile-control {modulation-default mod_prof_id | modulation-profile mod_prof_id}
  profile-ncp modulation-default <mod_prof_id>
  profile-data channel_data_prof_id {modulation-default mod_prof_id | modulation-profile
mod_prof_id}
```

Configure RPD Port/Controller and Channel

To configure the port or controller and channel, use the following commands.

```
enable
configure terminal
cable rpd <rpd_name_string>
 identifier <xxxx.xxxx.xxxx>
 core-interface Te slot/subslot/port
  principal
  rpd-ds <port> downstream-cable slot/subslot/port profile <ID>
  rpd-us <port> upstream-cable slot/subslot/port profile <ID>

cable downstream controller-profile <ID>
max-ofdm-spectrum value

rf-chan [id]
type DOCSIS
frequency value
  rf-output NORMAL
  qam-profile id
  docsis-channel-id id
rf-chan [id]
  docsis-channel-id id
  ofdm channel-profile id start-frequency value width value [plc value]
```

The OFDM channel IDs range from 158 to 162.

Configure RF Channel Bandwidth in Wideband Interface

To add the RF channel to a wideband interface, and to specify the RF channel bandwidth allocated for the channel, use the following commands:

Note Cisco cBR router does not support Dynamic Bandwidth Sharing (DBS). Hence, the bandwidth-percentage value does not apply.

```
enable
configure terminal
interface Wideband-Cable{slot/subslot/port}:wideband-channel
 cable bundle id
```

```
cable rf-channels channel-list grouplist bandwidth-percent percentage-bandwidth
```

Verify the Profile Ordering

To view the details of the profile downgrade ordering on a specific OFDM channel, run the following command:

```
Router#show controllers downstream-cable 7/0/0 rf-channel 158 prof-order

OFDM channel data profile order: [2/0/3:158]
-----------------------------------------------
Data Profile:       Downgrade Profile:
 Profile 1     ->    Profile 0
 Profile 2     ->    Profile 1
 Profile 3     ->    Profile 2
```

Verify OFDM Channel Profile

To view the details of an OFDM Channel Profile, run the following command:

```
Router# show controllers downstream-Cable 7/0/0 rf-channel 158 verbose

Chan State Admin Mod-Type  Start       Width     PLC      Profile-ID dcid output
                           Frequency
158   UP   UP   OFDM      807000000   192000000 963000000     20     162  NORMAL
 Resource status:   OK
 License: granted <20:11:58 CST Jul 3 2017>
 OFDM channel license spectrum width: 128200000
 Config lock status: Open
 OFDM config state: Configured

 OFDM channel details: [7/0/0:158]
-----------------------------------------
 OFDM channel frequency/subcarrier range     : 807000000[ 128] - 998999999[3967]
 OFDM spectrum frequency/subcarrier range    : 800600000[   0] - 1005399999[4095]
 Active spectrum frequency/subcarrier range  : 808900000[ 166] - 997049999[3929]
 OFDM channel center frequency/subcarrier    : 903000000[2048]
 PLC spectrum start frequency/subcarrier     : 963000000[3248]
 PLC frequency/subcarrier                    : 965800000[3304]
 Channel width                               : 192000000
 Active Channel width                        : 128200000
 OFDM Spectrum width                         : 204800000
 Chan prof id                                : 20
 Cyclic Prefix                               : 1024
 Roll off                                    : 128
 Interleave depth                            : 16
 Spacing                                     : 50KHZ
 Pilot Scaling                               : 48
 Control modulation default                  : 1024
 NCP modulation default                      : 16
 Data modulation default                     : None
 Data modulation profile                     : None
 Lower guardband width in freq/subcarriers   : 1900000[38]
 Upper guardband width in freq/subcarriers   : 1900000[38]

 PLC spectrum frequencies [subcarriers]             :
  963000000[3248] - 968999999[3367]

 PLC channel frequencies [subcarriers]                :
  965800000[3304] - 966199999[3311]   Size: 8 subcarriers
```

```
 Excluded frequencies [subcarriers]                :
  800600000[   0] - 808899999[ 165]     865000000[1288] - 924999999[2487]
  997100000[3930] - 1005399999[4095]
  Count: 1532

 Pilot frequencies [subcarriers]                   :
  *:PLC pilots
  810150000[ 191]   812700000[ 242]   815250000[ 293]   817800000[ 344]
  820350000[ 395]   822900000[ 446]   825450000[ 497]   828000000[ 548]
  830550000[ 599]   833100000[ 650]   835650000[ 701]   838200000[ 752]
  840750000[ 803]   843300000[ 854]   845850000[ 905]   848400000[ 956]
  Count: 4

 Active frequencies [subcarriers]                  :
  808900000[ 166] - 864999999[1287]     925000000[2488] - 997099999[3929]
  Count: 2564

 Data frequencies [subcarriers]                    :
  808900000[ 166] - 810149999[ 190]     810200000[ 192] - 812699999[ 241]
  812750000[ 243] - 815249999[ 292]     815300000[ 294] - 817799999[ 343]
  817850000[ 345] - 820349999[ 394]     820400000[ 396] - 822899999[ 445]
  822950000[ 447] - 825449999[ 496]     825500000[ 498] - 827999999[ 547]

..
  Count: 2500

 Profiles:
  Number of profiles: 2
  CTRL profile (Profile A): rate: 864000 kbps
  Active frequencies [subcarriers]:
  Modulation:Start-freq[start-subcarrier] - End-freq[end-subcarrier]
  ------------------------------------------------------------------
  1024 :808900000[ 166] - 810100000[ 190]     1024 :810200000[ 192] - 812650000[ 241]
  1024 :812750000[ 243] - 815200000[ 292]     1024 :815300000[ 294] - 817750000[ 343]
  1024 :817850000[ 345] - 820300000[ 394]     1024 :820400000[ 396] - 822850000[ 445]
  1024 :822950000[ 447] - 825400000[ 496]     1024 :825500000[ 498] - 827950000[ 547]

...

Active subcarrier count: 2500, ZBL count: 0
  Discontinuity time [days:hours:mins:secs]: 00:00:00:00

  NCP profile:
  Active frequencies [subcarriers]:
  Modulation:Start-freq[start-subcarrier] - End-freq[end-subcarrier]
  ------------------------------------------------------------------
  16   :808900000[ 166] - 810100000[ 190]     16   :810200000[ 192] - 812650000[ 241]
  16   :812750000[ 243] - 815200000[ 292]     16   :815300000[ 294] - 817750000[ 343]
  16   :817850000[ 345] - 820300000[ 394]     16   :820400000[ 396] - 822850000[ 445]
  16   :822950000[ 447] - 825400000[ 496]     16   :825500000[ 498] - 827950000[ 547]
…
  Active subcarrier count: 2500, ZBL count: 0

 CCCs:
   OCD CCC: 1
   DPD CCCs:
     Control profile  (Profile A) CCC: 1
         NCP profile  CCC: 1
 Resource config time taken: 29 msecs
 JIB channel number: 768
Chan Pr  EnqQ  Pipe  RAF  SyncTmr DqQ ChEn  RAF Tun# SessionId Valid P/S XFI 0[TkbRt MaxP]
     1[TkbRt MaxP]
 768  0  384     0   308      0   384  1    5551 0   16778240  TRUE   0  0 479610000 4485120
```

```
 383688000 4485120
 768  1  384     0  4786      0   384  1    2190 0   16778240  TRUE   0  0 479610000 4485120
 383688000 4485120
Encap Chan-id Data:0 PLC:5
Chan   Qos-Hi   Qos-Lo    Med-Hi   Med-Lo    Low-Hi   Low-Lo
 768    24576    16384     24576    16384     40960    24576
Chan  Med Low TB-neg Qos_Exc  Med_Xof  Low_Xof  Qdrops(H-M-L)  Pos Qlen(Hi-Med-lo) Fl Tgl_cnt
 Rdy_sts
  768   0   0      0       0        0        0    0    0    0  Y    0      0      0  0
    0 ff
Chan       Rate   Neg   Pos    LastTS  CurrCr  Pos  [PLC Rate Neg Pos]
 768   10485750 65535 65535 123395759 268431360   Y [MM 86 128 1024][EM 87 128 6144][TR 2
9 3072]
```

Verify OFDM Channel

To view the details of an OFDM channel, run the following command:

```
Router#show controllers downstream-Cable 7/0/0 counter ofdm-channel

Controller Chan# Profile/PLC Packets   Bytes MaxRate  Rate       Utilization
                                             (Mbps)   (Mbps)     (%)
7/0/0      158   Total        101694 9225522    -  0.015590   0.0
7/0/0      158   0             29216 2557604  864  0.004551   0.0
7/0/0      158   PLC-MMM       72474 6667608       0.011039
7/0/0      158   PLC-EM            0       0       0.000000
7/0/0      158   PLC-TR            0       0       0.000000
```

Verify OCD and DPD of MAC Domain

To display the MAC domain's OFDM Channel Descriptor (OCD) and Downstream Profile Descriptor (DPD) messages, use the **show cable mac-domain dpd | ocd** command in privileged EXEC mode.

```
Router# show cable mac-domain cable 7/0/0 ocd

DCID: 162  OFDM Controller:channel 7/0/0:158

OCD Message
  MAC Header
    Frame Control                  : 0xC2   (MAC specific, MAC msg, EHDR Off)
    MAC Parameters                 : 0x0
    Length                         : 190
    Header Check Sequence          : 0x84A2 (33954)
  MAC Management Header
?
    Destination MAC ADDR           : 01e0.2f00.0001
    Source MAC ADDR                : c414.3c17.3ead
    Length                         : 172
    Destination SAP                : 0
    Source SAP                     : 0
    Control                        : 3
    Version                        : 5
    Type                           : 49
    Multipart                      : 0    (Sequence number 0, Fragments 0)
  OCD fields
    DCID                           : 162
    CCC                            : 1
    TLV 0 Spacing                  : 50 KHz
    TLV 1 Cyclic Prefix            : 1024 samples
```

```
    TLV 2 Rolloff                   : 128 samples
    TLV 3 Spectrum Location         : 800600000 Hz
    TLV 4 Interleave Depth          : 16
    TLV 5 Subcarrier Assignment     : Continuous Pilots (list)
      0191  0242  0293  0344  0395  0446  0497  0548  0599  0650
      0701  0752  0803  0854  0905  0956  1007  1058  1109  1160
      1211  1262  2513  2564  2615  2666  2717  2768  2819  2870
      2921  2972  3023  3074  3125  3176  3227  3257  3269  3280
      3289  3326  3335  3346  3358  3398  3449  3500  3551  3602
      3653  3704  3755  3806  3857  3908
    TLV 5 Subcarrier Assignment     : Excluded Subcarriers (range)
                                    : 0000 - 0165
    TLV 5 Subcarrier Assignment     : Excluded Subcarriers (range)
                                    : 1288 - 2487
    TLV 5 Subcarrier Assignment     : Excluded Subcarriers (range)
                                    : 3930 - 4095
    TLV 5 Subcarrier Assignment     : PLC Subcarriers (range)
                                    : 3304 - 3311
    TLV 6 Primary Capable           : 0 (No)
-------------------------------------------------------------------------------
```

Verify Profile Management Data

To view the detailed profile management data associated with each cable modem.

```
Router#show cable modem c0c6.87ff.dabc prof-mgmt

Downstream Profile Management Data:
MAC Address            : c0c6.87ff.dcea
IP Address             : 60.11.0.12
IPv6 Address           : ---

RxMer Exempt Percent   : 2
RxMer Margin qDB       : 0
Automatic Prof Dwngrd  : Active

DCID                                  : 162
  Configured Profile(s)               : 0
  Profile(s) in REG-RSP-MP            : 0
  Profile(s) in DBC-REQ               : N/A
  Current profile                     : 0  [1024-QAM]
  Percentages of ideal BL vs Curr Prof : 96 (better)  3 (equal)
  Downgrade profile                   : 0
  Recommend profile                   : 0
  Unfit profile(s)                    : N/A
  Recommend profile (Expired)         : N/A
  Unfit profile(s)  (Expired)         : N/A
Number of SubCarriers  : 4096
1st Active SubCarrier  : 166
# of Active SubCarriers: 3764
Tx Time                : 0h:15m:15s ago
Rx Time                : 0h:15m:15s ago
OFDM Profile Failure Rx: N/A
MER Poll Period   (min): 60
Recommend Timeout (min): 120
Unfit Timeout     (min): 60
Source              : OPT
Sub-    RxMER
Carrier
0x0000  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x0020  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x0040  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
```

```
0x0060  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x0080  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x00A0  00000000 0000A5A3 A4A1A2A1 A5A3A39E A5A3A6A4 A6A1A6A2 A3A69FA2 A1A4A4A2
0x00C0  A2A0A4A4 A49EA7A6 A4A29EA4 A2A2A1A4 A3A1A1A4 A4A3A0A6 A4A1A4A6 A4A4A2A5
0x00E0  A5A2A3A5 A8A3A3A3 A6A1A1A0 A2A3A4A4 A3A2A19E A4A89FA3 A4A4A3A4 A4A4A5A2
0x0100  A5A3A1A1 A0A4A59E 9FA2A3A3 9F9FAAA4 A5A09FA4 A4A1A2A6 9DA1A1A0 A4A2A4A3
0x0120  A3A0A3A8 A29FA5A5 A3A6A1A0 A69EA1A2 A1A2A3A2 A1A2A3A5 9FA6A4A5 A1A7A4A4
0x0140  A5A4A5A1 A3A4A2A4 A2A2A4A3 A1A2A5A4 A19FA4A5 A1A0A5A4 9FA4A1A1 A6A2A59F
0x0160  A1A2A4A5 A3A5A4A1 A4A3A5A1 A3A3A5A0 A0A3A3A0 A2A3A3A3 A2A2A2A5 A5A4A4A3
0x0180  9EA4A3A1 A4A5A2A3 A29FA39F A6A1A0A2 A4A59FA3 A4A2A4A1 A2A4A3A3 A6A39DA2
0x01A0  A3A1A1A2 A3A2A2A1 A2A0A39F A7A39FA5 A1A4A4A1 A2A4A2A0 A6A49F9F A6A39D9F
0x01C0  9FA2A5A2 9BA1A1A0 A3A2A1A3 A39FA3A1 A19EA3A5 9DA1A0A0 A3A0A39F A0A3A2A1
0x01E0  A5A4A0A1 A0A39F9E A09FA2A4 9FA2A39F A2A3A49C A3A29FA0 A0A3A2A5 A3A0A1A1
… …
Upstream Profile Management Data:
```

Verify OCD and DPD Messages in RPD

To view OCD and DPD messages from RPD, run the following command. The output must be identical to the messages on Cisco cBR-8 routers.

```
RPD-config# show downstream ofdm configuration
OCD Message

  OCD fields
    DCID                            : 0
    CCC                             : 1
    TLV 0 Spacing                   : 50 KHz
    TLV 1 Cyclic Prefix             : 1024 samples
    TLV 2 Rolloff                   : 128 samples
    TLV 3 Spectrum Location         : 800600000 Hz
    TLV 4 Interleave Depth          : 16
    TLV 5 Subcarrier Assignment     : Continuous Pilots (list)
      191   242   293   344   395   446   497   548   599   650
      701   752   803   854   905   956   1007  1058  1109  1160
      1211  1262  2513  2564  2615  2666  2717  2768  2819  2870
      2921  2972  3023  3074  3125  3176  3227  3257  3269  3280
      3289  3326  3335  3346  3358  3398  3449  3500  3551  3602
      3653  3704  3755  3806  3857  3908
    TLV 5 Subcarrier Assignment     : Excluded Subcarriers (range)
                                    : 0    - 165
    TLV 5 Subcarrier Assignment     : Excluded Subcarriers (range)
                                    : 1288 - 2487
    TLV 5 Subcarrier Assignment     : Excluded Subcarriers (range)
                                    : 3930 - 4095
    TLV 5 Subcarrier Assignment     : PLC Subcarriers (range)
                                    : 3304 - 3311
    TLV 6 Primary Capable           : 1 (Yes)

DPD Message
  DPD fields
    DCID                            : 0
    Profile ID                      : 0
    CCC                             : 1
    TLV 5 Subcarrier Range/List     : Range (continuous)
      Modulation                    : 1024 (default value)
                                    : 0    - 4095
DPD Message
  DPD fields
    DCID                            : 0
    Profile ID                      : 255
    CCC                             : 1
```

```
    TLV 5 Subcarrier Range/List     : Range (continuous)
      Modulation                    : 16 (default value)
                                    : 0    - 4095
```

Verify per-Profile Counter on RPD

The following example shows how to verify the per-profile counter on RPD:

```
RPD-config# show downstream ofdm counter profile

Profile Pkts       Sum-Pkts   Bytes      Sum-Bytes  Codewords  Sum-Codewords
0       7735       7735       677110     677110     4815       4815
1       0          0          0          0          0          0
2       0          0          0          0          0          0
3       0          0          0          0          0          0
4       0          0          0          0          0          0
5       0          0          0          0          0          0
6       0          0          0          0          0          0
7       0          0          0          0          0          0
8       0          0          0          0          0          0
9       0          0          0          0          0          0
10      0          0          0          0          0          0
11      0          0          0          0          0          0
12      0          0          0          0          0          0
13      0          0          0          0          0          0
14      0          0          0          0          0          0
15      0          0          0          0          0          0
```

Verify the Drop Counter in DPS

To verify the drop counter, especially in the DPS module, run the following command:

```
RPD-config#show downstream channel counter
------------------- Packets counter in TPMI -------------------

Level     Rx-pkts    Rx-sum-pkts
Node Rcv  32690704   32690704
Depi Pkt  32471383   32471383

Port Chan Rx-pkts    Rx-sum-pkts
DS_0 0    3599407    3599407
DS_0 1    3605066    3605066


DS_0 5    3602293    3602293
DS_0 6    3596193    3596193
DS_0 7    3598393    3598393
DS_0 8    599        599
US_0 5    598656     598656

Port      Rx-pkts    Rx-sum-pkts Drop-pkts  Drop-sum-pkts
DS_0      28998897   28998897    0          0
US_0      3602539    3602539     0          0
US_1      2244       2244        0          0


------------------- Packets counter in DPMI -------------------
```

```
Field        Pkts       Sum-pkts
Dpmi Ingress 28844845   28844845
Pkt Delete   0          0
Data Len Err 0          0

Chan Flow_id Octs       Sum-octs   SeqErr-pkts SeqErr-sum-pkts
0    0       374242     374242     1           1
0    1       710485     710485     1           1
0    2       218477141  218477141  1           1
0    3       0          0          0           0
1    0       379530     379530     1           1
1    1       700973     700973     1           1
1    2       218859695  218859695  1           1
1    3       0          0          0           0
2    0       372126     372126     1           1
2    1       695623     695623     1           1


31   2       0          0          0           0
31   3       0          0          0           0
158  0       0          0          0           0
158  1       682214     682214     1           1
158  2       0          0          0           0
158  3       0          0          1           1
163  0       0          0          0           0
163  1       0          0          1           1
163  2       0          0          0           0
163  3       1654620    1654620    1           1


------------------- Packets counter in DPS -------------------

Chan Tx-packets Tx-octets  Drop-pkts  Tx-sum-pkts Tx-sum-octs Drop-sum-pkts
0    3599803    219580072  0          3599803     219580072   0
1    3605466    219958582  0          3605466     219958582   0
2    3602414    219728291  0          3602414     219728291   0
3    3604543    219858566  0          3604543     219858566   0


31   599        20366      0          599         20366       0
158  7797       682524     0          7797        682524      0
```

Configuration Example

The following example shows how to configure OFDM channel:

```
cable downstream ofdm-chan-profile 0
  description System Profile 0
  cyclic-prefix 1024
  interleaver-depth 16
  pilot-scaling 48
  roll-off 128
  subcarrier-spacing 50KHZ
  profile-control modulation-default 256-QAM
  profile-ncp modulation-default 16-QAM
  profile-data 1 modulation-default 1024-QAM

cable downstream controller-profile 100
 max-ofdm-spectrum 192000000
 rf-chan 0 7
  type DOCSIS
```

```
  frequency 453000000
  rf-output NORMAL
  qam-profile 1
  docsis-channel-id 1
 rf-chan 158
  docsis-channel-id 159
  ofdm channel-profile 0 start-frequency 645000000 width 192000000 plc 651000000

cable rpd node_0873
 identifier 0004.9f00.0873
 core-interface Te7/1/0
  principal
  rpd-ds 0 downstream-cable 7/0/0 profile 100
  rpd-us 0 upstream-cable 7/0/0 profile 1
```

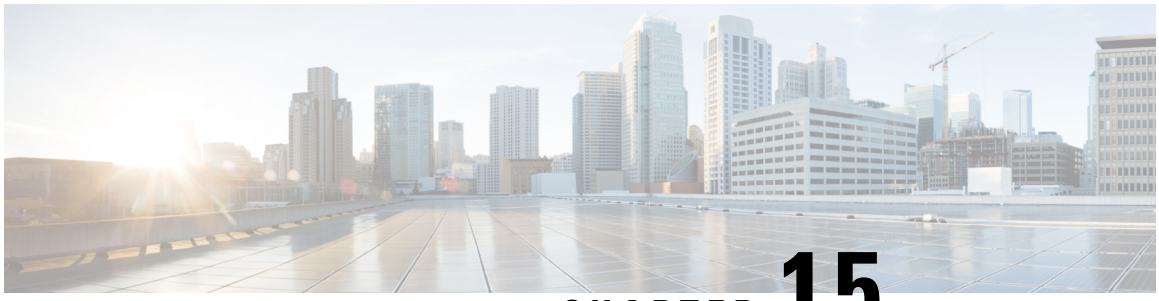
Feature Information for RPHY DS OFDM Channel Configuration

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 www.cisco.com/go/cfn 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 28: Feature Information for RPHY DS OFDM Channel Configuration

Feature Name	Releases	Feature Information
Remote PHY DS OFDM Channel Configuration	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.



CHAPTER 15

Virtual Combining of Upstream Channels on RPD

This chapter provides information on the support for virtual combining of upstream channels on Cisco Remote PHY Devices.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 29: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information About Virtual Combining of Upstream Channels

Virtual Combining helps in supporting more RPDs than the number of US SGs, similar to the way multiple physical cables are combined to the same upstream RF port in I-CMTS architecture.

In RPHY, a group of Upstream External PHY Interface (UEPI) sessions with different pseudowires are set up for a single upstream channel for both CCAP core and RPD. However, with virtual-combing, multiple UEPI sessions are mapped to one physical channel in Cisco cBR-8 Routers.

Through this feature, Cisco cBR-8 routers support the binding of multiple US ports on RPDs to the same US controller. The USPHY configuration on the combined RPDs is the same. All combined RPDs must use the same type of USPHY chip.

You are notified if an RPD USPHY is incompatible with the USPHY configuration when a new RPD comes online.

The combined US ports may be in the same RPD. The combined US ports may be in different RPDs. The maximum number of combined US ports to the same controller must not exceed 8. The combined USPHY channels share the bandwidth of the combined channel.

At any instance, only one USPHY channel can transmit. Cisco cBR Series routers support the modems under a specific RPD even in combined US channel cases. It also supports all member USPHY channel information in a combined channel.

When monitoring a physical channel, the cable monitor monitors all member UEPI channels. Spectrum surveillance collects and calculates the SNR and CNR for each USPHY channel.

The OFDMA channels supported for the Virtual Combining feature on Remote PHY start from 8192. The number of ATDMA channels supporting this feature are 256 physical channels for IPHY and 1024 for Remote PHY.

Configure Virtual Combining of Upstream Channels

Note To know more about the commands referenced in this section, see the Cisco IOS Master Command List.

Configure RPD for Virtual Combining

The virtual combining of upstream channels is initiated automatically when users configure the same US controller for more than one US ports. The ports may be in the same RPD or different RPDs, but should be on the same line card).

In the following example, the US port 0 on RPD node_1 and US port 0 and 1 on RPD node_2 are combined to upstream-cable 9/0/2.

```
cable rpd node_<number>
 identifier badb.ad13.5d7e
 core-interface Te9/1/2
  principal
  rpd-ds 0 downstream-cable 9/0/2 profile 100
  rpd-us 0 upstream-cable 9/0/2 profile 221
 r-dti 1
!
cable rpd node_2
 identifier badb.ad13.5d96
 core-interface Te9/1/2
  principal
  rpd-ds 0 downstream-cable 9/0/2 profile 100
  rpd-us 0 upstream-cable 9/0/2 profile 221
  rpd-us 1 upstream-cable 9/0/2 profile 221
 r-dti 1
!
```

Verify Upstream Virtual Combining Details

To view the spectrum analysis measurements of the specified UEPI channels for virtual combining, use the following sample commands:

```
show cable spectrum-analysis Cable <slot/subslot/port> upstream <port> sid <Sid of modem
or noise> devID <0-7 Device ID>
Load for five secs: 5%/1%; one minute: 5%; five minutes: 5%
No time source, *11:16:00.436 CST Sat Feb 24 2018

Spectrum Analysis Measurements for Cable9/0/7: Upstream 0 Sid 1
Device ID: 1
Channel Center Frequency: 10000 kHz
Frequency Span:           3200 kHz
Number of Bins:           129
Bin Spacing:              25.0 kHz
Resolution Bandwidth:     42.750 kHz
Amplitude Data:
    Bin   1: -60.00 dBmV
    Bin   2: -60.00 dBmV
    Bin   3: -60.00 dBmV
    Bin   4: -32.00 dBmV
    Bin   5: -23.00 dBmV
    Bin   6: -22.00 dBmV
```

To view the signal quality of the specified channels supporting virtual combining, use the following sample commands:

```
show cable signal-quality cmts
I/F           DevID    CNiR            Expected Received
                       (dB)            Signal Power (dBmV)
Cable1/0/0/U0   0      31.0            0.0
Cable1/0/0/U0   1      31.0            0.0
```

```
Cable1/0/0/U0   2      31.0            0.0
Cable1/0/0/U1   0      31.0            0.0
Cable1/0/0/U1   1      31.0            0.0
Cable1/0/0/U2          -----           -----
Cable1/0/0/U3          -----           -----
Cable1/0/0/U4   0      31.0            0.0
Cable1/0/0/U5   0      31.0            0.0
```

To view the status of upstream channel combining, use the following sample commands:

```
show controllers upstream-cable 7/0/62 us-channel 0

Load for five secs: 5%/1%; one minute: 6%; five minutes: 5%
Time source is NTP, 18:05:11.271 CST Tue Feb 27 2018

Controller RPD US Port List:

DevID  RPD ID          US Port  I/F       Name
------ --------------- -------- --------- ------------
  0    0004.9f03.0226     0     Te7/1/1   0004.9f03.0226
  1    0004.9f03.0286     0     Te7/1/1   0004.9f03.0286
  2    1004.9f30.1500     0     Te7/1/0   1004.9f30.1500
  3    1004.9f30.1500     1     Te7/1/0   1004.9f30.1500

USPHY OFDMA support: NO

Controller 7/0/62 upstream 0  AdminState:UP OpState: UP
  atdma mode enabled
  Frequency 21.800 MHz, Channel Width 1.600 MHz, Symbol Rate 1.280 Msps
  Modulation Profile Group 221
  Modulations (64-QAM) - A-short 64-QAM, A-long 64-QAM, A-ugs 64-QAM

  Mapped to connector 62 and receiver 0
  Bind to Cable7/0/0 US0
  US phy MER(SNR)_estimate for good packets - 42.410 dB
  Spectrum Group is overridden
  Nominal Input Power Level 0 dBmV
  part_id=0x0000, rev_id=0x00, rev2_id=0x00
  Range Load Reg Size=0x58
  Request Load Reg Size=0x0E
  Minislot Size in number of Timebase Ticks is = 4
  Minislot Size in Symbols = 32
  Minislot Size in Bytes = 24

  UCD procedures on lch 0
  UCD ucd-succeed         (3   ) invalid-req         (0   ) md-dispatch         (0   )
  UCD mismatch-req        (0   ) start-sw            (0   ) start-state         (0   )
  UCD ccc-time            (0   ) end-sw              (0   ) end-state           (0   )
  UCD ucd-lch-tgc         (0   ) ucd-rcvr            (0   ) ucd-cdm-timeout     (0   )
  UCD ucd-no-reqtxn       (0   ) ucd-req-chn-mismatch(0   ) ucd-send-next-fail  (0   )
  UCD ucd-rpd-np          (0   ) ucd-upd-gcp-msg     (0   ) ucd-cfg-gcp-msg     (0   )
  UCD ucd-gcp-ack         (0   ) ucd-gcp-ack-timeout (0   ) ucd-gcp-nack        (0   )
  UCD ucd-gcp-timout      (0   ) ucd-ack-err         (0   ) ucd-timer-null      (0   )
  UCD ucd-proxy-timeout   (0   ) ucd-proxy-wrong-ack (0   )
  PHY: us errors 0  us recoveries 0 (enp 0)
  MAC PHY TSS: tss error start 0  tss error end 0
  MAC PHY Status: mask 0  int_index 0
  PHY: TSS late 0  discontinuous 0
  PHY: TSS mis-match 0  not-aligned 0
  PHY: TSS missed snapshots from phy 0
  Map Counts:0
LCH_state RUN_STEADY   , UCD_count 3, MD 0 chan 0
```

Configuration Example

This section provides example of how to configure the RPD for virtual combining of upstream channels.

Example for Configuring RPD for Virtual Combining

```
cable rpd node_1
 identifier badb.ad13.5d7e
 core-interface Te9/1/2
  principal
  rpd-ds 0 downstream-cable 9/0/2 profile 100
  rpd-us 0 upstream-cable 9/0/2 profile 221
 r-dti 1
!
cable rpd node_2
 identifier badb.ad13.5d96
 core-interface Te9/1/2
  principal
  rpd-ds 0 downstream-cable 9/0/2 profile 100
  rpd-us 0 upstream-cable 9/0/2 profile 221
  rpd-us 1 upstream-cable 9/0/2 profile 221
 r-dti 1
!
```

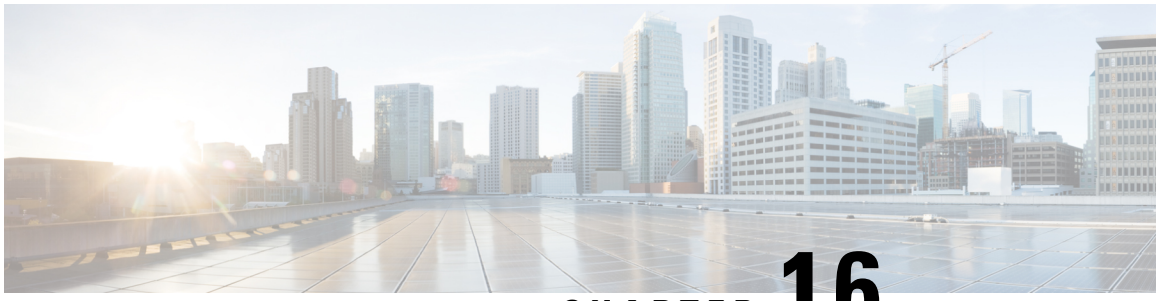
Feature Information for Virtual Combining of Upstream Channels

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 www.cisco.com/go/cfn 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 30: Feature Information for NIT Reference Support

Feature Name	Releases	Feature Information
Virtual Combining of Upstream Channels on Remote PHY	Cisco 1x2 RPD Software 4.1	This feature was introduced on the Cisco Remote PHY Devices.



CHAPTER 16

DOCSIS3.1 Downstream Resiliency for RPHY

This document describes how to configure the DOCSIS3.1 Downstream Resiliency on the Cisco Remote PHY Device.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 31: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information about DOCSIS3.1 Downstream Resiliency for RPHY

When DOCSIS3.1 cable modem reports non-primary RF channel failure for SCQAM or OFDM channel, actions performed by downstream resiliency is the same as DOCSIS3.0 cable modem. In other words, if RF channel impairment is below the resiliency threshold, CM's service flows are moved to Resiliency Bonding Group (RBG) or Narrow Band (NB) interface. If RF channel impairment is above the resiliency threshold, the impaired RF channel is temporarily removed from the bonding group.

The following table summarizes the CM-STATUS events for OFDM channel, and the action taken by the downstream resiliency module:

Table 32: CM-STATUS events for OFDM channel

Event Type Code	Event Description	DS Resiliency Action
1	MDD timeout	Move CM's service flows to RBG/NB or suspend RF from BG.
2	FEC lock failure	Move CM's service flows to RBG/NB or suspend RF from BG.

Event Type Code	Event Description	DS Resiliency Action
4	MDD recovery	Move CM's service flows back to original BG.
5	FEC lock recovery	Move CM's service flows back to original BG.
16	DS OFDM profile failure. A loss of FEC lock on one of the assigned downstream OFDM profiles of a channel.	DS OFDM Profile Manager will handle this event and take action.
20	NCP profile failure. Loss of FEC lock on NCP.	Move CM's service flows to RBG/NB or suspend RF from BG.
21	Loss of FEC lock on the PLC.	Move CM's service flows to RBG/NB or suspend RF from BG.
22	NCP profile recovery.	Move CM's service flows back to original BG.
23	FEC recovery on PLC channel.	Move CM's service flows back to original BG.
24	FEC recovery on OFDM profile.	Recovery of impairment reported by event 16. DS OFDM Profile Manager will handle this event and take action.

Configure DOCSIS3.1 Downstream Resiliency for RPHY

Note To know more about the commands referenced in this module, see the Cisco IOS Master Command List.

Configure DOCSIS3.1 Downstream Resiliency for RPHY

User must configure the command **cable rf-change-trigger percent** *value* **count** *number* to enable the downstream resiliency functionality.

To configure the trigger thresholds specific to OFDM RF impairment, follow the steps below:

```
enable
configure terminal
cable ofdm-rf-change-trigger percent value counter number [no-ncp-plc]
```

Trigger thresholds *value* and *number* apply globally to the non-primary OFDM RF channels. If this command is not configured, the trigger thresholds configured by the command **cable rf-change-trigger percent** *value* **count** *number* will be used for the non-primary OFDM channels.

With **no-ncp-plc** configured in the command, this feature will not take any action when CM reports CM-STATUS-EVENT 20 or 21.

Note The **cable rf-change-trigger percent** *value* **count** *number* command is optional and the configured trigger thresholds apply to non-primary OFDM channels only.

Display OFDM Specific CM-STATUS Events

To display the statistics of the OFDM specific CM-STATUS events, use the **show cable modem wideband rcs-status** command as shown in the example below:

```
router#show cable modem 4800.33ea.7072 wideband rcs-status verbose
CM  : 4800.33ea.7072
RF  : 3/0/0 0
  Status                  : UP
  FEC/QAM Failure         : 0
  Dup FEC/QAM Failure     : 0
  FEC/QAM Recovery        : 0
  Dup FEC/QAM Recovery    : 0
  MDD Failure             : 0
  Dup MDD Failure         : 0
  MDD Recovery            : 0
  Dup MDD Recovery        : 0
  Flaps                   : 0
  Flap Duration           : 00:00
RF  : 3/0/0 159
  Status                  : UP
  FEC/QAM Failure         : 0
  Dup FEC/QAM Failure     : 0
  FEC/QAM Recovery        : 0
  Dup FEC/QAM Recovery    : 0
  MDD Failure             : 0
  Dup MDD Failure         : 0
  MDD Recovery            : 0
  Dup MDD Recovery        : 0
  NCP PROF Failure        : 2         May 8  15:14:24
  Dup NCP PROF Failure    : 0
  NCP PROF Recovery       : 1         May 8  15:15:18
  Dup NCP PROF Recovery   : 0
  PLC Lock Recovery       : 1         May 8  15:15:46
  Dup PLC Lock Recovery   : 0
  Flaps                   : 0
  Flap Duration           : 00:00
  OFDM Profile Id : 2
  Status                  : UP
  Profile Failure         : 1         May 8  15:16:18
  DUP Profile Failure     : 0
  Profile Recovery        : 1         May 8  15:16:44
  DUP Profile Recovery    : 0
```

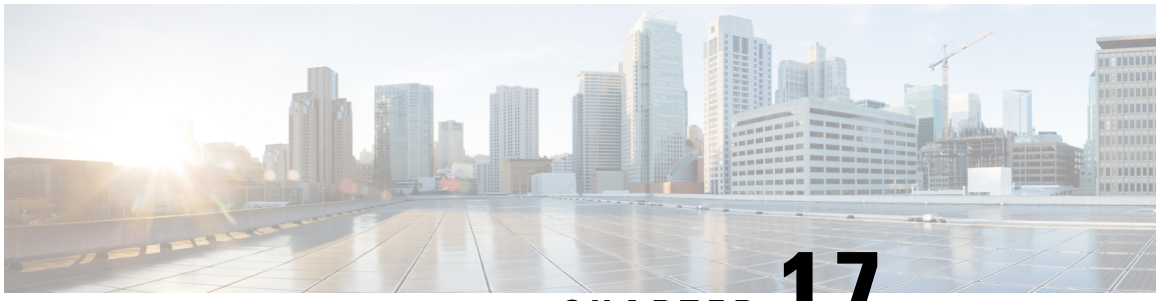
Feature Information for DOCSIS3.1 Downstream Resiliency for RPHY

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 www.cisco.com/go/cfn 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 33: Feature Information for DOCSIS3.1 Downstream Resiliency for RPHY

Feature Name	Releases	Feature Information
DOCSIS3.1 Downstream Resiliency for RPHY	Cisco 1x2 / Compact Shelf RPD Software 4.1	This feature was introduced on the Cisco Remote PHY Device.



CHAPTER 17

Dynamic Bonding Group for RPHY

The Dynamic Bonding Group (DBG) feature enables the system to automatically create bonding groups of different sizes based on the cable modems' capacity. It helps to manage the resources of all downstream bonding groups. When the number of available bonding groups reaches the lower limit, it reclaims the bonding groups that match the reclaim threshold set by the user. The modems used on these bonding groups are then moved to other bonding groups without primary channel change. This move makes space for new bonding group allocations. This automated way of creating and reclaiming bonding groups greatly reduces the management effort of RCC configuration. DBG also automatically accommodates primary channel and CM capacity distributions.

The load balancing feature leverages DBG to balance traffic among all channels. With DBG, the modem is assigned to the downstream bonding group without any static RCC configuration.

DBG supports the following:

- DOCSIS 3.0 and DOCSIS 3.1 channel types.
- DOCSIS 3.0 and DOCSIS 3.1 load balance.
- Interoperation with modem registration, load balancing, and high availability.
- Enhanced dynamic load balance to allow movement of modem without a change in the primary channel.
- Enhanced FPGA to allow channel utilization fairness.

This chapter describes how to configure the DBG feature on the Cisco Remote PHY Device.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 34: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Configure Dynamic Bonding Group

Before configuring DBG, it is assumed that interface Mac domain and fiber node are already configured on the Cisco cbr-8 router. The recommended primary channel distribution is one primary channel for contiguous four channels, such as 0, 4, 8, 12, 16, 20, 24, 28 and so on. For more information, see DOCSIS Interface and Fiber Node Configuration in the Cisco cBR Converged Broadband Routers DOCSIS Software Configuration Guide.

Note To know more about the commands referenced in this module, see the Cisco IOS Master Command List.

Enable Dynamic Bonding Group

DBG is disabled by default. Use **cable dynamic-bonding-group** command to enable DBG as shown in the following example:

```
ROUTER# configure terminal
ROUTER(config)# cable dynamic-bonding-group
ROUTER(config)# end
```

To configure the bonding group reclaim threshold, use **cable dynamic-bonding-group reclaim-threshold** command as shown in the following example:

```
ROUTER# configure terminal
ROUTER(config)# cable dynamic-bonding-group reclaim-threshold percent 5% modems 6
ROUTER(config)# end
```

5% is the default bonding group throughput percentage threshold, and 6 is the default cable modem count threshold. If the throughput of a bonding group is lower than 5% of all bonding groups' throughput, and this bonding group has less than 6 cable modems assigned to it, then this bonding group is reclaimed when the available bonding groups reach the lower limit (20%).

By default, cable modem registration and load balance trigger DBG creation when needed. If you want to disable the interoperation with cable modem registration and load balance, use the commands in the following example:

```
ROUTER# configure terminal
ROUTER(config)# no cable dynamic-bonding-group registration

ROUTER# configure terminal
ROUTER(config)# no cable dynamic-bonding-group load-balance
```

When DBG is enabled, we recommend you to complete the following configurations.

Enable DS-Resiliency and Configure Resiliency Bonding Group

To make sure that the modem is still in w-online state with maximum downstream capability when several RF channels are impaired, enable the ds-resiliency feature by running the following commands:

```
Router# configure terminal
Router(config)# cable resiliency ds-bonding
Router(config)# end


Router# configure terminal
Router(config)# interface wideband-Cable 3/0/1:30
Router(config-if)# cable ds-resiliency
Wideband-Cable3/0/1:30 is set to WB resiliency bonding group.
Remove any existing bundle and rf-channel configuration.
Router(config-if)# end
```

Enable ACFE

Enable ACFE feature to make sure that modem registration is not blocked because of QoS failures:

```
Router# configure terminal
```

```
Router(config)# cable acfe enable
Router(config)# end
```

Verify Dynamic Bonding Group Configuration

This section describes how to use certain **show** commands to verify if the dynamic bonding groups are created.

Check the modem's primary wideband interface using the **show cable modem wideband channel** command as shown in this example:

```
Router# show cable modem 4800.33ee.ebee wideband channel
MAC Address          IP Address          I/F          MAC         DSxUS      Primary
                                                     State                  WB
4800.33ee.ebee       30.132.15.246       C3/0/1/UB    w-online    32x2       Wi3/0/1:3
```

Check the modem's downstream tuner capability using the **show cable modem verbose | in DS Tuner** command as shown in the following example:

```
Router# show cable modem 4800.33ee.ebee verbose | in DS Tuner
DS Tuner Capability : 32
```

Check the related RCC using the **show cable mac-domain rcc** command as shown in the following example:

```
Router# show cable mac-domain c3/0/1 rcc
RCC-ID   RCP             RCs  MD-DS-SG  CMs  WB/RCC-TMPL        D3.0    D3.1
32       00 00 00 00 00  8    0         11   WB (Wi3/0/1:1)     Y       Y
33       00 00 00 00 00  32   0         6    WB (Wi3/0/1:3)     Y       Y
34       00 00 00 00 00  8    0         7    WB (Wi3/0/1:2)     Y       Y
35       00 00 00 00 00  8    0         7    WB (Wi3/0/1:4)     Y       Y
36       00 00 00 00 00  8    0         7    WB (Wi3/0/1:5)     Y       Y
```

Check the dynamically created bonding groups using the **show cable dynamic-bonding-group summary** command as shown in the following example:

```
Router# show cable dynamic-bonding-group summary
Dynamic bonding group: Enable
BG ID BG Name   BG Size CMs ServFlows Create Time         Create Client       BG State
RFid list
24834 Wi3/0/1:1 8       11  11        Sep 14 14:36:35.194 MODEM_ONLINE        OPERATIONAL
24832-24839
24836 Wi3/0/1:3 32      6    6        Sep 14 14:43:24.144 MODEM_ONLINE        OPERATIONAL
24832-24863
24835 Wi3/0/1:2 8       7    7        Sep 14 17:20:37.115 MODEM_ONLINE        OPERATIONAL
24840-24847
24837 Wi3/0/1:4 8       7    7        Sep 14 17:21:37.723 STATIC_LOAD_BALANCE OPERATIONAL
24856-24863
24838 Wi3/0/1:5 8       7    7        Sep 14 17:21:39.761 STATIC_LOAD_BALANCE OPERATIONAL
24848-24855
```

This example shows the DBG with D31 modems:

```
Router# show cable mac-domain c1/0/4 rcc
RCC-ID   RCP             RCs  MD-DS-SG  CMs   WB/RCC-TMPL       D3.0   D3.1
7        00 00 00 00 00  33   0         51    WB (Wi1/0/4:2)    N      Y
8        00 00 00 00 00  8    0         2     WB (Wi1/0/4:3)    Y      Y
9        00 00 00 00 00  8    0         1     WB (Wi1/0/4:4)    Y      Y

Router# show cable dynamic-bonding-group summary
Dynamic bonding group: Enable
```

```
BG ID BG Name      BG Size  CMs  ServFlows Create Time           Create Client        BG
State             RFid list
9219  Wi1/0/4:2    33       51   51        Sep 26 13:56:00.337   MODEM_ONLINE
OPERATIONAL          9216-9247, 9375
9220  Wi1/0/4:3    8        2    2         Sep 26 13:56:19.011   MODEM_ONLINE
OPERATIONAL          9216-9223
9221  Wi1/0/4:4    8        1    1         Sep 26 13:56:36.090   MODEM_ONLINE
OPERATIONAL          9240-9247
```

Table 35: Dynamic Bonding Group States

DBG State	Description
CREATE_WAITING_SUP	Line card sends a request to create DBG and waits for SUP to create the bonding group.
HOLD	DBG is created from SUP, or bonding group reverts from reclaim to ready-for-use state.
OPERATIONAL	If a modem is used on the bonding group after the HOLD state times out, the DBG state changes to OPERATIONAL.
RECLAIM_HOLD	Ready for reclaim. If no modem is used on the bonding group or match the reclaim in two minutes, the bonding group is reclaimed. The DBG state changes to RECLAIM_HOLD.
RECLAIM_MODEM_MOVING	Ready for reclaim. The modem is moved out of the bonding group.
RECLAIM_WAITING_SUP	Line card sends a DBG reclaim request and waits for SUP to reclaim the BG.

To display the detailed channel list information of dynamic bonding group, use the **show derived-config interface wideband** command as shown in the following example:

```
Router# show derived-config interface wideband-Cable 3/0/1:1
Building configuration...
Derived configuration: 113 bytes
!
interface Wideband-Cable3/0/1:1
  cable bundle 255
  cable rf-channels channel-list 0-7 bandwidth-percent 1
end
```

Check the usage of bonding group resource using the **show cable dynamic-bonding-group quota** command.

```
Router# show cable dynamic-bonding-group quota controller 3/0/1
slot/subslot/ctrlr: 3/0/1
Total BG number: 128
Used BG number (static/dynamic): 6(1/5) Available BG number: 122
Available BG list port: 0, 6-29, 31-127
```

Check the reclaimed bonding group using the **show cable dynamic-bonding-group reclaim-history summary** command:

```
Router# show cable dynamic-bonding-group reclaim-history summary
BG ID BG Name   BG Size Create Time     Create Client Reclaim Time    Reclaim Client RFid
list
24835 Wi3/0/1:2 16      Sep 14 14:40:27 MODEM_ONLINE  Sep 14 14:44:27 DBG_INTERNAL
24832-2484
```

Configure Load Balancing with Dynamic Bonding Group Enabled

If you want to use load balancing with the DBG enabled, we recommend that you configure the load balancing as shown here.

Enable Load Balancing for DOCSIS 3.0 and DOCSIS 3.1

To enable DOCSIS load balancing, run the following commands:

```
Router# config terminal
Router(config)# cable load-balance docsis-enable
Router(config)# end
```

When DOCSIS load balancing is enabled, run the following commands to enable load balancing for DOCSIS 3.0 and DOCSIS 3.1.

```
Router# config terminal
Router(config)# cable load-balance docsis30-enable
Router(config)# end
```

Enable DOCSIS 3.0 and DOCSIS 3.1 Static Load Balance

To balance the load of primary channels, enable static load balance using the following commands:

```
Router# configure terminal
Router(config)# cable load-balance docsis30-enable static
Router(config)# end
```

Enable DOCSIS 3.0 and DOCSIS 3.1 General Load Balance Group

To enable general load balance group, use cable load-balance docsis-group command as shown here:

```
Router# configure terminal
Router(config)# cable load-balance docsis-group fn 1 md c3/0/1
Router(config-lb-group)# no disable
Router(config-lb-group)# end
```

Enable Dynamic Load Balance and Fixed-Primary Channel Movement

To balance the load of all downstream channels based on utilization, enable dynamic load balance by running the following commands:

```
Router# configure terminal
```

```
Router(config)# cable load-balance docsis30-enable dynamic downstream
Router(config)# end
```

Fixed primary channel movement is disabled by default. With dynamic load balancing enabled, we recommend that you enable fixed primary channel movement to reduce service outage by running the following commands:

```
Router# configure terminal
Router(config)# cable load-balance fixed-primary-channel
Router(config)# end
```

Verify Static Load Balancing Configuration

This section describes how to use **show** commands to verify the configuration of the static load balancing.

Check the load of all primary channels using the **show cable load-balance docsis-group load** command as shown here:

```
Router# show cable load-balance docsis-group fn 1 md c3/0/1 load | in In
Interface            State   Group      Utilization Rsvd NBCM WB/UB Weight
In3/0/1:0(573 MHz)   initial 2147557888 0%(0%/0%)   0%   0    17    37
In3/0/1:4(597 MHz)   initial 2147557888 0%(0%/0%)   0%   0    17    37
In3/0/1:8(621 MHz)   initial 2147557888 0%(0%/0%)   0%   0    13    37
In3/0/1:12(645 MHz) initial 2147557888 0%(0%/0%)   0%   0    13    37
In3/0/1:16(669 MHz) initial 2147557888 0%(0%/0%)   0%   0    13    37
In3/0/1:20(693 MHz) initial 2147557888 0%(0%/0%)   0%   0    13    37
In3/0/1:24(717 MHz) initial 2147557888 0%(0%/0%)   0%   0    13    37
In3/0/1:28(741 MHz) initial 2147557888 0%(0%/0%)   0%   0    13    37
```

This command output lists all primary channels and shows the number of cable modems used with these channels. NBCM is the number of narrowband modems used with a channel while WBCM (WB/UB) is the number of wideband modems used with a channel. The total number of WBCMs must be balanced among all channels.

The difference between the total number of WBCMs used with any two channels is smaller or equal to the minimum threshold load. The default value of the minimum threshold load is 5.

This example shows the load in DOCSIS 3.1 static load balancing configuration:

```
Router# show cable load-balance docsis-group fn 33 md c3/0/0 load | i In
Interface            State    Group      Utilization Rsvd NBCM WB/UB Weight
In3/0/0:0(453 MHz)   initial  2147557408 1%(0%/1%)   0%   0    16    37
In3/0/0:8(501 MHz)   initial  2147557408 1%(0%/1%)   0%   0    16    37
In3/0/0:30(633 MHz) initial  2147557408 1%(0%/1%)   0%   0    12    37
In3/0/0:40(693 MHz) initial  2147557408 1%(0%/1%)   0%   0    15    37
In3/0/0:55(783 MHz) initial  2147557408 1%(0%/1%)   0%   0    12    37
In3/0/0:158(258 MHz initial  2147557408 1%(0%/1%)   0%   0    21    224

   - Above example, the modem count balanced with a configured threshold of 5

  - Count based load balancing is done only on sc-qam channels of equal weight. OFDM channel
 is of much higher weight and is excluded from the modem count calculations.
```

Check the load of all RF channels using the **show cable load-balance docsis-group rfch-util** command as shown in this example:

```
Router# show cable load-balance docsis-group fn 1 md c3/0/1 rfch-util
Interface  Pstate Pending-In Pending-Out Throughput(Kbps) Util NBCM WBCM
In3/0/1:0  up     No         No          0                0%   0    17
In3/0/1:1  NA     No         No          0                0%   0    17
In3/0/1:2  NA     No         No          0                0%   0    17
```

```
In3/0/1:3  NA     No          No          0                0%   0    17
In3/0/1:4  up     No          No          0                0%   0    17
In3/0/1:5  NA     No          No          0                0%   0    17
In3/0/1:6  NA     No          No          0                0%   0    17
In3/0/1:7  NA     No          No          0                0%   0    17
In3/0/1:8  up     No          No          0                0%   0    13
In3/0/1:9  NA     No          No          0                0%   0    13
In3/0/1:10 NA     No          No          0                0%   0    13
In3/0/1:11 NA     No          No          0                0%   0    13
In3/0/1:12 up     No          No          0                0%   0    13
In3/0/1:13 NA     No          No          0                0%   0    13
In3/0/1:14 NA     No          No          0                0%   0    13
In3/0/1:15 NA     No          No          0                0%   0    13
……
Average: 0.0
Variance: 0.0
```

This command lists the load information of the primary and secondary channels. WBCM is the number of wideband modems used with a channel.

Check the cable modem's internal state in load balancing using the **show cable load-balance docsis-group modem-list wideband** command as shown in this example:

```
Router# show cable load-balance docsis-group fn 1 md c3/0/1 modem-list wideband
Codes: M - Multicast, U - UGS, P - PCMM, F - Max-Failures, X - eXcluded
       L - L2vpn, R - RSVP, S - DS-Resiliency
Primary WB    MAC Address     Primary DS  RCC-ID Priority MUPFXLRS State
Wi3/0/1:0     (3)
              c8fb.2631.0e56  In3/0/1:20  41     0        ------   LB_CM_HOLD_EXPIRE_IN 36
              c8fb.26a6.c3dc  In3/0/1:16  41     0        ------   LB_CM_HOLD_EXPIRE_IN 37
              c8fb.2631.0d7e  In3/0/1:16  41     0        ------   LB_CM_HOLD_EXPIRE_IN 43
Wi3/0/1:1     (9)
              c8fb.2631.0c80  In3/0/1:0   32     0        ------   LB_CM_STATIC_MOVING
              c8fb.2631.0cae  In3/0/1:0   32     0        ------   LB_CM_STATIC_READY
              c8fb.2631.0db0  In3/0/1:24  42     0        ------   LB_CM_STATIC_MOVING
              c8fb.2631.0c10  In3/0/1:28  42     0        ------   LB_CM_STATIC_MOVING
              c8fb.2631.0d80  In3/0/1:16  41     0        ------   LB_CM_STATIC_MOVING
              c8fb.2631.0d26  In3/0/1:24  41     0        ------   LB_CM_STATIC_MOVING
              a4a2.4a2d.b4aa  In3/0/1:20  41     0        ------   LB_CM_STATIC_MOVING
              c8fb.2631.0e5c  In3/0/1:0   32     0        ------   LB_CM_STATIC_MOVING
              c8fb.2631.0cb0  In3/0/1:0   32     0        ------   LB_CM_STATIC_MOVING
Wi3/0/1:2     (3)
              c8fb.2631.0d2a  In3/0/1:12  34     0        ------   LB_CM_HOLD_EXPIRE_IN 27
              c8fb.2631.0e5a  In3/0/1:12  34     0        ------   LB_CM_STATIC_MOVING
              c8fb.2631.0bfe  In3/0/1:8   34     0        ------   LB_CM_STATIC_MOVING
Wi3/0/1:3     (2)
              4800.33ea.54be  In3/0/1:28  33     0        ------   LB_CM_DYNAMIC_READY
              4800.33ee.ebe6  In3/0/1:20  33     0        ------   LB_CM_HOLD_EXPIRE_IN 1
Wi3/0/1:4     (2)
              c8fb.2631.0e44  In3/0/1:24  42     0        ------   LB_CM_HOLD_EXPIRE_IN 40
              c8fb.2631.0a44  In3/0/1:28  42     0        ------   LB_CM_HOLD_EXPIRE_IN 42
```

Table 36: Cable Modem States

CM State	Description
LB_CM_STATIC_READY	Modem is ready for static load balance movement.
LB_CM_STATIC_MOVING	Modem is in movement triggered by static load balance.

CM State	Description
LB_CM_HOLD_EXPIRE_IN	Modem is in hold for the next movement. The default hold time, in seconds, is 600.
LB_CM_DYANMIC_READY	Modem is ready for dynamic load balance movement.
LB_CM_DYANMIC_MOVING	Modem is in movement triggered by dynamic load balance.
LB_CM_DISABLED	Modem is not ready for movement. If the modem failure movement count reaches maximum failure threshold, then set the modem in LB_CM_DISABLED to avoid further movement.

Verify Dynamic Load Balancing Configuration

This section describes how to use the **show** commands to verify the configuration of the dynamic load balancing.

Check the utilization of all RF channels using **show cable load-balance docsis-group rfch-util** command as shown in this example:

```
Router# show cable load-balance docsis-group fn 320 md c3/0/0 rfch-util
Interface  Pstate Pending-In Pending-Out Throughput(Kbps) Util NBCM WBCM
Do3/0/0:0  up     No         No          11754            31%  0    308
Do3/0/0:1  up     No         No          11754            31%  0    296
Do3/0/0:2  up     No         No          11754            31%  0    333
Do3/0/0:3  up     No         No          11754            31%  0    296
Do3/0/0:4  up     No         No          11754            31%  0    297
Do3/0/0:5  up     No         No          11754            31%  0    331
Do3/0/0:6  up     No         No          11754            31%  0    299
Do3/0/0:7  up     No         No          11753            31%  0    268
Do3/0/0:8  up     No         No          11754            31%  0    302
Do3/0/0:9  up     No         No          11754            31%  0    331
Do3/0/0:10 up     No         No          11753            31%  0    308
Do3/0/0:11 up     No         No          11754            31%  0    305
Do3/0/0:12 NA     No         No          12862            34%  0    258
Do3/0/0:13 NA     No         No          12862            34%  0    258
Do3/0/0:14 NA     No         No          12862            34%  0    258
……
Average: 30.416
Variance: 1.701
```

The traffic among all RF channels is considered balanced when the difference between any two RF channel utilization is under the threshold load. The default percentage of threshold load is 10%.

To check the potential target bonding group for each of the source bonding group, use the **show cable load-balance docsis-group target dbg** and the **show cable load-balance docsis-group target wide** commands as shown in this example:

```
Router# show cable load-balance docsis-group fn 320 md c3/0/0 target dbg
Interface      Bg-Id       Size     Group           Target
Wi3/0/0:0      24577       4        2147557695
Wi3/0/0:3      24580       4        2147557695
Wi3/0/0:4      24581       8        2147557695
Wi3/0/0:5      24582       8        2147557695
Wi3/0/0:6      24583       24       2147557695      33% [24576, 24584-24587, 24589-24607]
```

```
Wi3/0/0:7      24584       16       2147557695      30% [24576, 24586-24587, 24595-24607]
Wi3/0/0:8      24585       16       2147557695
Wi3/0/0:9      24586       32       2147557695
Wi3/0/0:10     24587       24       2147557695      33% [24576, 24584-24587, 24589-24607]
Wi3/0/0:11     24588       8        2147557695
Wi3/0/0:12     24589       8        2147557695      27% [24596-24603]
Wi3/0/0:13     24590       8        2147557695
Wi3/0/0:14     24591       4        2147557695
```

```
Router# show cable load-balance docsis-group fn 5 md c1/0/4 target wide
Interface      Bg-Id       State    Group           Target
Wi1/0/4:2      9219        up       2147510276      Wi1/0/4:4
Wi1/0/4:3      9220        up       2147510276
Wi1/0/4:4      9221        up       2147510276
```

If there is no target bonding group in the output, it means that no bonding groups are created to balance traffic among RF channels.

A sample output for DOCSIS 3.1 modems with a configured threshold of 14% is shown. For utilization based load balancing to start on DOCSIS 3.1 modems, the OFDM channel must be utilized 100% and SC-QAM must have traffic. The utilization-based load balancing balances the traffic on the SC-QAM channels in a DOCSIS 3.1 modem.

```
Router# show cable load-balance docsis-group fn 5 md c1/0/4 rfch-util
Interface     Pstate  Pending-In  Pending-Out  Throughput(Kbps)  Util  NBCM  WBCM
In1/0/4:0     up      No          No           10632             28%   0     45
In1/0/4:1     NA      No          No           11226             29%   0     41
In1/0/4:2     NA      No          No           11225             29%   0     41
In1/0/4:3     NA      No          No           11225             29%   0     41
In1/0/4:4     down    No          No           11225             29%   0     41
In1/0/4:5     down    No          No           11225             29%   0     41
In1/0/4:6     down    No          No           11225             29%   0     41
In1/0/4:7     down    No          No           11225             29%   0     41
In1/0/4:8     up      No          No           10620             28%   0     43
....
....
In1/0/4:35    NA      No          No           6646              17%   0     6
In1/0/4:36    NA      No          No           6646              17%   0     6
In1/0/4:37    NA      No          No           6647              17%   0     6
In1/0/4:38    NA      No          No           6646              17%   0     6
In1/0/4:39    NA      No          No           6647              17%   0     6
In1/0/4:40    up      No          No           6088              16%   0     6
In1/0/4:41    NA      No          No           6648              17%   0     6
In1/0/4:42    NA      No          No           6647              17%   0     6
In1/0/4:43    NA      No          No           6647              17%   0     6
In1/0/4:44    NA      No          No           6646              17%   0     6
In1/0/4:45    NA      No          No           6646              17%   0     6
In1/0/4:46    No      No          No           6647              17%   0     6
In1/0/4:47    NA      No          No           6648              17%   0     6
In1/0/4:48    NA      No          No           6648              17%   0     6
In1/0/4:49    NA      No          No           6648              17%   0     6
In1/0/4:50    NA      No          No           6646              17%   0     6
In1/0/4:51    NA      No          No           6648              17%   0     6
In1/0/4:52    NA      No          No           6647              17%   0     6
In1/0/4:53    NA      No          No           6648              17%   0     6
In1/0/4:54    No      No          No           6647              17%   0     6
In1/0/4:55    NA      No          No           6648              17%   0     6
In1/0/4:56    NA      No          No           6647              17%   0     6
In1/0/4:57    NA      No          No           6647              17%   0     6
In1/0/4:58    NA      No          No           6646              17%   0     6
In1/0/4:59    NA      No          No           6645              17%   0     6
In1/0/4:60    NA      No          No           6646              17%   0     6
In1/0/4:61    NA      No          No           6646              17%   0     6
In1/0/4:62    NA      No          No           6647              17%   0     6
```

```
In1/0/4:63    NA      No          No          6647              17%   0     6
In1/0/4:159   NA      No          No          1819685           100%  0     47
```

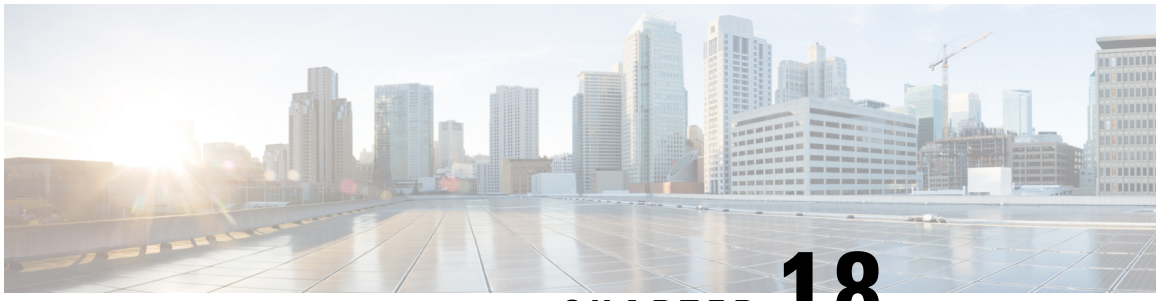
Feature Information for Dynamic Bonding Group

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 www.cisco.com/go/cfn 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 37: Feature Information for Dynamic Bonding Group

Feature Name	Releases	Feature Information
Dynamic Bonding Group	Cisco 1x2 / Compact Shelf RPD Software 4.1	This feature was introduced on the Cisco Remote PHY Device.



CHAPTER 18

Cisco Remote PHY Device IPv6

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 38: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information about RPD IPv6

The CableLabs' MHAv2 standards requires CCAP Core and RPD must support both IPv4 and IPv6, which means the Remote PHY Signaling between the CCAP Core and RPD is able to run on both IPv4 and IPv6 networks.

Note

- CCAP Core can support IPv4/IPv6 dual stack.
- RPD can support either IPv4 or IPv6 network.
- RPD does not support IPv4/IPv6 Dual Stack at the same time.
- RPD will try IPv6 connection first. When DHCPv6 failed, RPD will try DHCPv4.
- For single RPD, all the server addresses, protocols to communicate with it must be in the same IP version.

Configure RPD IPv6 Unicast Online

This section describes how to configure RPD IPv6 Unicast Online on Cisco cBR-8.

Note To know more about the commands referenced in this module, see the Cisco IOS Master Command List.

Configure Unicast IPv6

To configure Unicast IPv6, complete the following procedure:

1. Enable IPv6 unicast routing.

```
configure terminal
ipv6 unicast-routing
```

2. Configure IPv6 Address on DPIC interface.

```
configure terminal
interface TenGigabitEthernet slot/1/port
ipv6 enable
ipv6 address ipv6_address
```

Configure RPD core interface

To configure RPD core interface, complete the following procedure:

```
configure terminal
cable rpd name
identifier rpd_mac
core-interface tenG_interface
principal
rpd-ds id downstream-cable controller profile id
rpd-us id upstream-cable controller profile id
```

Configure IPv6 PTP Clock Option

To configure the IPv6 PTP Clock Option, complete the following procedure:

1. Configure CBR as PTP slave, see the configuration example below:

```
configure terminal
    interface Loopback1588
        ip address 158.158.158.5 255.255.255.255
    ptp clock ordinary domain 0
        servo tracking-type R-DTI
        clock-port slave-from-903 slave
        delay-req interval -4
        sync interval -5
        sync one-step
        transport ipv4 unicast interface Lo15888 negotiation
        clock source 10.90.3.93
```

Note CCAP-Core as PTP slave can only support IPv4.

2. Configure R-DTI for RPD PTP IPv6.

```
configure terminal
ptp r-dti number
ptp-domain domain
clock-port number
ethernet number
transport ipv6
clock source ipv6 address gateway ipv6 geteway
```

Note
- PTP domain and 1588 master have same domain number.
- Clock source IPv6 address is 1588 master IPv6 address.
- Gateway is next hop to 1588 master, and it is optional.
- For RPD, ethernet 1=vbh0, ethernet 2=vbh1, ethernet 0 will choose either vbh0 or vbh1 which is functional as clock-port.

3. Associate R-DTI with RPD configuration.

```
configure terminal
cable rpd id
r-dti number
```

Verify IPv6 PTP Clock Option Configuration

To display the CBR PTP Status, use the **show ptp clock running** command as shown in the example below:

```
Router# show ptp clock running
Load for five secs: 6%/2%; one minute: 7%; five minutes: 8%
No time source, *05:11:13.610 UTC Sun Oct 22 2017
PTP Ordinary Clock [Domain 0]
         State          Ports          Pkts sent      Pkts rcvd      Redundancy Mode
         PHASE_ALIGNED  1              2478203        7512533        Hot standby
                              PORT SUMMARY
                                                                                PTP Master
Name           Tx Mode      Role         Transport    State        Sessions     Port Addr

slave-from-903 unicast      slave        Lo15888      Slave        1            10.90.3.93
```

To display the RPD PTP Status, use the **show ptp clock** command as shown in the example below:

```
Router# show ptp clock 0 config
Domain/Mode         :   0/OC_SLAVE
Priority 1/2/local  : 128/255/128
Profile             : 001b19000100-000000 E2E
Total Ports/Streams : 1  /1
--PTP Port  23, Enet Port   1 ----
  Port local Address :2001:120:102:70:7:1b71:476c:70ba
```

```
  Unicast   Duration :300 Sync Interval : -4
  Announce  Interval :  0 Timeout       : 11
  Delay-Req Intreval : -4 Pdelay-req    : -4
  Priority  local    :128 COS:  6   DSCP: 47
  ==Stream 0 : Port 23 Master IP: 2001:10:90:3::93

Router# show ptp clock 0 state
apr state       : PHASE_LOCK
clock state     : SUB_SYNC
current tod     : 1508640223   Sun Oct 22 02:43:43 2017
active stream   : 0
==stream    0   :
  port id       :                0
  master ip     : 2001:10:90:3::93
  stream state  :       PHASE_LOCK
  Master offset :             3490
  Path    delay :           -27209
  Forward delay :           -27333
  Reverse delay :           -27085
  Freq offset   :          6544364
  1Hz  offset   :               49

Router# show ptp clock 0 statistics
 AprState    4  :
           2@0-00:06:25.027          1@0-00:06:15.382          0@0-00:03:51.377
           4@0-00:03:32.176
 ClockState  5  :
           5@0-00:06:36.141          4@0-00:06:33.684          3@0-00:06:30.510
           2@0-00:06:25.512          1@0-00:06:24.982
 BstPktStrm  1  :
           0@0-00:06:15.987
 StepTime    1  :
   908222863@0-00:05:42.199
 AdjustTime  2589       :
        -339@1-20:18:42.949       -321@1-20:17:41.949         49@1-20:16:40.949
         145@1-20:15:39.949          6@1-20:14:38.949        261@1-20:13:37.949
         327@1-20:12:36.949         76@1-20:11:35.949        157@1-20:10:34.949
streamId  msgType           rx          rxProcessed     lost        tx
 0        SYNC              2549177     2549177         4292476931  0
 0        DELAY REQUEST     0           0               0           2549150
 0        P-DELAY REQUEST   0           0               0           0
 0        P-DELAY RESPONSE  0           0               0           0
 0        FOLLOW UP         0           0               0           0
 0        DELAY RESPONSE    2549144     2549144         4292476934  0
 0        P-DELAY FOLLOWUP  0           0               0           0
 0        ANNOUNCE          159330      159330          4294836225  0
 0        SIGNALING         1662        1662            0           1663
 0        MANAGEMENT        0           0               0           0
   TOTAL                    5259313     5259313         12879790090 2550813
```

Verify RPD IPv6 Configuration

To display the RPD IPv6 Status, use the **show cable rpd ipv6** command as shown in the example below:

```
Router# show cable rpd ipv6
Load for five secs: 7%/2%; one minute: 9%; five minutes: 8%
No time source, *14:03:13.622 UTC Sun Oct 22 2017
MAC Address     I/F       State        Role HA  Auth IP Address
0004.9f03.0226  Te0/1/6   online       Pri  Act N/A  2001:120:102:70:7:1B71:476C:70BA
0004.9f03.0232  Te0/1/7   online       Pri  Act N/A  ---
0004.9f03.0256  Te0/1/2   online       Pri  Act N/A  2001:120:102:70:3:830A:FAEA:CF7E
0004.9f03.0268  Te0/1/6   online       Pri  Act N/A  2001:120:102:70:7:41F1:7CCD:4475
```

```
0004.9f03.0268  Te6/1/6   online       Aux  Act N/A  2001:120:102:70:7:41F1:7CCD:4475
badb.ad13.5d7e  Te0/1/2   online       Pri  Act N/A  2001:120:102:70:3:FF46:1FF9:29FE
```

Configure IPv6 DS Splitting

This section describes how to configure RPD IPv6 DS splitting on Cisco cBR-8. In this configuration, different RPDs share the same DS SG traffic. For each DS sharing controller, one unique IPv6 multicast IP is assigned according to multicast pool. When RPD is IPv6 online, all DS sharing Controller associated multicast IPs are IPv6 type. Multiple DS controllers used by one RPD core must be either IPv4 or IPv6 and cannot be mixed. RPD sharing same DS Controller must only be IPv4 or IPv6 online and cannot be mixed. Multiple RPD cores in one RPD must only be IPv4 or IPv6 online and cannot be mixed.

Note To know more about the commands referenced in this module, see the Cisco IOS Master Command List.

Configure the multicast IPv6 DEPI pool

To configure multicast IPv6 DEPI pool, complete the following procedure:

```
configure terminal
cable depi multicast pool id
ipv6 address ip/prefix
```

Enable Multicast Sharing under Downstream Controller Profile

To configure Unicast IPV6, complete the following procedure (same as IPv4 downstream splitting):

```
configure terminal
cable downstream controller-profile id
multicast-pool id
```

Configure the RPD with the Same Downstream Controller and Profile

To configure the RPDs with the same downstream controller and profile, complete the procedure as shown in the example below (same as IPv4 downstream splitting):

```
configure terminal
    cable rpd node_1
        core-interface tenGigabitEthernet 9/1/0
               rpd-ds 0 controller downstream-cable 9/0/0 profile 0
               rpd-us 0 controller upstream-cable 9/0/0 profile 221
    cable rpd node_2
        core-interface tenGigabitEthernet 9/1/0
               rpd-ds 0 controller downstream-cable 9/0/0 profile 0
               rpd-us 0 controller upstream-cable 9/0/0 profile 221
```

Configure the RPDs to different fiber-nodes

To configure the RPDs to different fiber-nodes, complete the procedure as shown in the example below (same as IPv4 downstream splitting):

```
configure terminal
    cable fiber-node 100
           downstream Downstream-Cable 9/0/0
            upstream Upstream-Cable 9/0/0
    cable fiber-node 101
           downstream Downstream-Cable 9/0/0
            upstream Upstream-Cable 9/0/1
```

Configure the RPDs to MAC Domain

To configure the RPDs to the MAC domain, complete the procedure as shown in the example below (same as IPv4 downstream splitting):

```
configure terminal
    interface Cable9/0/0
        downstream Downstream-Cable 9/0/0 rf-channel 0
        downstream Downstream-Cable 9/0/0 rf-channel 8
        upstream 0 Upstream-Cable 9/0/0 us-channel 0
        upstream 1 Upstream-Cable 9/0/0 us-channel 1
        upstream 2 Upstream-Cable 9/0/0 us-channel 2
        upstream 3 Upstream-Cable 9/0/0 us-channel 3
        upstream 4 Upstream-Cable 9/0/1 us-channel 0
        upstream 5 Upstream-Cable 9/0/1 us-channel 1
        upstream 6 Upstream-Cable 9/0/1 us-channel 2
        upstream 7 Upstream-Cable 9/0/1 us-channel 3
        cable upstream bonding-group 1
          upstream 0
          upstream 1
          upstream 2
          upstream 3
          attributes 800000F0
        cable upstream bonding-group 2
          upstream 4
          upstream 5
          upstream 6
          upstream 7
          attributes 8000000F
```

Or use the following example (same as IPv4 downstream splitting):

```
configure terminal
    interface Cable9/0/0
        downstream Downstream-Cable 9/0/0 rf-channel 0
        upstream 0 Upstream-Cable 9/0/0 us-channel 0
        upstream 1 Upstream-Cable 9/0/0 us-channel 1
        upstream 2 Upstream-Cable 9/0/0 us-channel 2
        upstream 3 Upstream-Cable 9/0/0 us-channel 3
        cable upstream bonding-group 1
          upstream 0
          upstream 1
          upstream 2
          upstream 3
          attributes 800000F0
configure terminal
    interface Cable9/0/1
        downstream Downstream-Cable 9/0/0 rf-channel 8
        upstream 0 Upstream-Cable 9/0/1 us-channel 0
        upstream 1 Upstream-Cable 9/0/1 us-channel 1
        upstream 2 Upstream-Cable 9/0/1 us-channel 2
        upstream 3 Upstream-Cable 9/0/1 us-channel 3
        cable upstream bonding-group 1
          upstream 0
          upstream 1
```

```
upstream 2
upstream 3
attributes 800000F0
```

Enable IPv6 multicast on Cisco cBR-8 Router

To enable the IPv6 multicast on cBR-8, complete the following procedure:

```
configure terminal
ipv6 multicast-routing
```

If cBR-8 and RPD are connected in L2 network, we recommend to enable MLD Snooping in L2 switches.

Verify the IPv6 DS Splitting Configuration

To display the IPv6 multicast DEPI pool, use the **show cable depi multicast pool ipv6** command as shown in the example below:

```
Router# show cable depi multicast pool ipv6
Load for five secs: 8%/2%; one minute: 7%; five minutes: 8%
No time source, *06:57:11.898 UTC Sun Oct 22 2017
POOL ID    IPv6                                            DESCRIPTION
22         FF3B::8000:0/100
50         FF3A::8000:0/126                                zyq
100        FF39::8000:0/120                                zyq
Infra_C05#show cable depi multicast pool ipv6 id 22
Load for five secs: 8%/2%; one minute: 8%; five minutes: 8%
No time source, *07:00:03.577 UTC Sun Oct 22 2017
POOL ID    IPv6                                            DESCRIPTION
22         FF3B::8000:0/100
```

To display the assigned IPv6 multicast address, use the **show cable depi multicast ipv6** command as shown in the example below:

```
Router# show cable depi multicast ipv6 all
Load for five secs: 10%/3%; one minute: 8%; five minutes: 8%
No time source, *07:01:33.659 UTC Sun Oct 22 2017
IPv6                                          POOL ID    CONTROLLER
FF3A::8000:0                                  50         9/0/2(291)
FF3A::8000:1                                  50         9/0/28(317)
FF39::8000:0                                  100        9/0/29(318)
FF3A::8000:2                                  50         9/0/30(319)
Infra_C05#show cable depi multicast ipv6 FF3A::8000:0
Load for five secs: 7%/2%; one minute: 8%; five minutes: 8%
No time source, *07:01:44.020 UTC Sun Oct 22 2017
IPv6                                          POOL ID    CONTROLLER
FF3A::8000:0                                  50         9/0/2(291)
```

To display the relationship between the downstream controller profile and IPv6 multicast Pool, use the **show cable downstream controller-profile** command as shown in the example below:

```
Router# show cable downstream controller-profile 100
Load for five secs: 24%/3%; one minute: 10%; five minutes: 8%
No time source, *07:10:28.074 UTC Sun Oct 22 2017

Downstream controller-profile 100, type RPHY
Description:
Downstream controller-profile 100 is being used by controller Downstream-Cable:
  0/0/30,
  Admin:  UP
  MaxOfdmSpectrum: 192000000
```

```
  MaxCarrier: 158
  Mode: normal
  Free freq block list has 3 blocks:
    45000000  - 449999999
    594000000 - 602999999
    795000000 - 1217999999
  DS Splitting: Yes
  Multicast Pool ID: 50
  OFDM frequency exclusion bands: None

Configured RF Channels:
Chan Admin Frequency  Type        Annex Mod  srate Qam-profile  dcid  output
 0    UP   453000000  DOCSIS       B    256   5361  1           1     NORMAL
 1    UP   459000000  DOCSIS       B    256   5361  1           2     NORMAL
 2    UP   465000000  DOCSIS       B    256   5361  1           3     NORMAL
```

To display the RPD associated with the downstream controller, use the **show controllers downstream-Cable** command as shown in the example below:

```
Router# show controllers downstream-Cable 9/0/2 rpd
Load for five secs: 8%/2%; one minute: 9%; five minutes: 8%
No time source, *07:14:20.326 UTC Sun Oct 22 2017
Controller RPD DS Port List:(2 of 2)
  RPD ID           I/F       Name
  ---------------- --------- ----------------
  badb.ad13.5d7e   Te9/1/2   node_3
  0004.9f03.0256   Te9/1/2   node_5
```

When the DS Controller IPv4/IPv6 type and the RPD IPv4/IPv6 online type conflicts, the RPD log prompts the confliction as shown in the example below:

```
Router# show cable rpd 0004.9f00.0979 Te3/1/0 log reverse
RPD ID I/F Severity Time LOG INFORMATION
---------------- ---------- ------------ ----------------------
-------------------------------------------
0004.9f00.0979 Te3/1/0 ERROR
2017-09-23 21:44:52.851 RPD 0004.9f00.0979 CoreTe 3/1/0 reset connection due to unmatched
IPv4/IPv6 between GCP connection(IPv6) and Downstream Sharing Controllers 3/1/0(IPv4)
0004.9f00.0979 Te3/1/0 ERROR
2017-09-23 21:44:50.817 RPD 0004.9f00.0979 CoreTe 3/1/0 reset connection due to unmatched
IPv4/IPv6 between GCP connection(IPv6) and Downstream Sharing Controllers 3/1/0(IPv4)
```

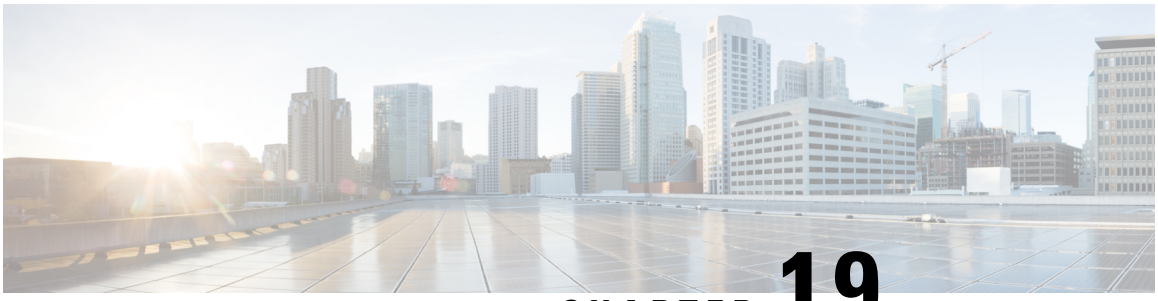
Feature Information for Remote-PHY Device IPv6

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

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

Table 39: Feature Information for Remote-PHY Device IPv6

Feature Name	Releases	Feature Information
Remote-PHY Device IPv6	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was introduced on the Cisco Remote PHY Device.



CHAPTER 19

DOCSIS 3.1 OFDMA Channel Configuration

This document describes the Remote PHY device DOCSIS 3.1 OFDMA channel configuration on the Cisco cBR Series Converged Broadband Router.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 40: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information about OFDMA Channel Configuration

DOCSIS 3.1 introduces modes for higher throughput and higher spectral efficiency while still allowing backward compatibility to DOCSIS 3.0. Orthogonal Frequency Division Multiple Access (OFDMA) channel has following features:

- Frequency-range up to 96 MHz
- Upstream spectrum 5 – 204 MHz
- 25 KHz and 50 KHz subcarrier spacing

Modulation Profile

A globally configured OFDMA modulation profile defines modulation orders and pilot patterns for different interval usage codes (IUC). It is also used to assign parameters for initial ranging and fine ranging.

OFDMA Channel Exclusion Band

Ranges of frequencies can be excluded from all OFDMA channels on a port using the **ofdma-frequency-exclusion-band** command.

Exclusion and unused bands apply to OFDMA channels only. OFDMA channel never use frequencies in the exclusion band. So the legacy SC-QAM channel can be placed in this band. OFDMA channel does not use frequencies in the unused band set by **ofdma-frequency-unused-band** command for data traffic, but can send probes in them.

Configure OFDMA Channel

Note To know more about the commands referenced in this module, see the Cisco IOS Master Command List.

Configure OFDMA Modulation Profile

The OFDMA modulation profile is used to configure initial ranging, fine ranging and data IUC parameters. To define the ofdma modulation profile to be applied to OFDMA channels, follow the steps below:

```
enable
configure terminal
cable mod-profile-ofdma id
subcarrier-spacing value
initial-rng-subcarrier value
fine-rng-subcarrier value
data-iuc id modulation value pilot-pattern value
```

Here is a configuration example:

```
Router# enable
Router# configure terminal
Router(config)# cable mod-profile-ofdma 451
Router(config-ofdma-mod-profile)# subcarrier-spacing 50KHz
Router(config-ofdma-mod-profile)# initial-rng-subcarrier 64
Router(config-ofdma-mod-profile)# fine-rng-subcarrier 128
Router(config-ofdma-mod-profile)# data-iuc 13 modulation 1024-QAM pilot-pattern 2
Router(config-ofdma-mod-profile)# exit
Router(config)# cable mod-profile-ofdma 472
Router(config-ofdma-mod-profile)# subcarrier-spacing 25KHz
Router(config-ofdma-mod-profile)# initial-rng-subcarrier 64
Router(config-ofdma-mod-profile)# fine-rng-subcarrier 128
Router(config-ofdma-mod-profile)# data-iuc 6 modulation 1024-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 9 modulation 1024-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 10 modulation 512-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 11 modulation 256-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 12 modulation 128-QAM pilot-pattern 9
Router(config-ofdma-mod-profile)# data-iuc 13 modulation 64-QAM pilot-pattern 9
```

Note

- Subcarrier spacing must match the subcarrier spacing of each channel profile in which it is configured.
- Modulation profiles 421 and 461 are the default modulation profiles for 25 KHz and 50 KHz subcarrier spacing respectively. You can add additional modulation profiles. The modulation profile range is between 401-500.
- You must configure subcarrier spacing, ranging, and data IUC 13 before applying modulation profile to a upstream channel.
- Regular pilot patterns (1-4/8-11) and boosted pilot patterns (5-7/12-14) cannot co-exist on the same upstream channel.
- We recommendto not change subcarrier spacing, ranging, and data IUC configuration of a modulation profile that is applied to a channel.

Verify OFDMA Modulation Profile Configuration

To display the OFDMA modulation profile details, use the **show cable modulation-profile ofdma** command as shown in the following example:

```
Router# show cable modulation-profile ofdma
Mod  Subc     IUC type   Act  Preamble  Bit       Pilot
     Spacing              subc Symbols   Loading   Pattern
421  25KHz    3  (IR)    64      4
              4  (FR)    192     1
              13 (data)                 16-QAM    8

423  25KHz    3  (IR)    64      4
              4  (FR)    128     1
              6  (data)                 1024-QAM  8
              10 (data)                 512-QAM   8
              11 (data)                 256-QAM   8
              12 (data)                 128-QAM   9
              13 (data)                 64-QAM    9

461  50KHz    3  (IR)    32      4
              4  (FR)    192     1
              13 (data)                 16-QAM    1

466  50KHz    3  (IR)    64      4
              4  (FR)    128     1
              13 (data)                 1024-QAM  2
```

Configure OFDMA Channel

To configure the OFDMA channel, follow these steps:

```
enable
configure terminal
cable upstream controller-profile id
us-channel id docsis-mode ofdma
us-channel id subcarrier-spacing value
us-channel id modulation-profile id
```

us-channel *id* **frequency-range** *start-value end-value*
us-channel *id* **initial-rng-frequency-start** *value*
us-channel *id* **cyclic-prefix** *value* **roll-off-period** *value*
us-channel *id* **symbols-per-frame** *value*
us-channel *id* **data-iuc** *id* **band** *start-value end-value* **modulation** *value* **pilot-pattern** *value*

To use QAM modulation in between specific bandwidth, use the **us-channel** *id* **data-iuc** *id* **band** *start-value end-value* **modulation** *value* **pilot-pattern** *value* command.

Here is a configuration example:

```
Router# enable
Router# configure terminal
Router(config)# cable upstream controller-profile 1
Router(config-controller-profile)# us-channel 12 docsis-mode ofdma
Router(config-controller-profile# us-channel 12 subcarrier-spacing 25KHz
Router(config-controller-profile)# us-channel 12 frequency-range 40000000 85000000
Router(config-controller-profile)# us-channel 12 modulation-profile 423
Router(config-controller-profile)# us-channel 12 cyclic-prefix 640 roll-off-period 224
Router(config-controller-profile)# us-channel 12 symbols-per-frame 9
Router(config-controller-profile)# us-channel 12 data-iuc 9 band 50000000 60000000 modulation
 512-QAM pilot-pattern 8
Router(config-controller-profile)# no us-channel 12 shutdown
```

Note

- A maximum of one OFDMA channel can be configured per controller. For this OFDMA channel, the us-channel index must be set to 12. This corresponds with OFDMA channel 0 on an RPD port.
- Change docsis-mode to **OFDMA** to enable OFDMA configuration options. These options are enabled by default on us-channel 12.
- We recommend that you configure no more than 4 active SC-QAMs while an OFDMA channel is present.
- OFDMA channel can be placed between 5 Mhz and 204 Mhz.
- Values of the options are often interdependent, changing one value may change other values or make them invalid.
- We recommend that you set subcarrier spacing and frequency range first. To achieve a higher OFDMA channel traffic throughput, configure OFDMA channel with 25kHz subcarrier spacing.
- Maximum of 4:1 upstream combining for OFDMA channels is supported.

Bind Upstream Controllers With RPHY Ports

If the upstream channel profile contains ODFMA channel, you can bind up to four RPD ports with the upstream controller.

```
cable rpd node1
 identifier badb.ad15.1288
 core-interface Te7/1/4
   principal
   rpd-ds 0 downstream-cable 7/0/30 profile 10
   rpd-us 0 upstream-cable 7/0/63 profile 1
   rpd-us 1 upstream-cable 7/0/63 profile 1
```

```
cable rpd node2
 identifier badb.ad15.1290
 core-interface Te7/1/4
   principal
   rpd-ds 0 downstream-cable 7/0/31 profile 10
   rpd-us 0 upstream-cable 7/0/63 profile 1
   rpd-us 1 upstream-cable 7/0/63 profile 1
```

Verify OFDMA Channel Configuration

To display the OFDMA channel configuration, use the **show controllers upstream-Cable us-channel** command as shown in the example below:

```
Router# show controllers upstream-Cable 1/0/4 us-channel 12
Controller RPD US Port List:
DevID RPD ID US Port I/F Name
------ --------------- -------- --------- ------------
0 badb.ad13.acfe 0 Te1/1/2 necker-5

USPHY OFDMA support: FULL


Controller 1/0/4 upstream 12  AdminState:UP OpState: UP
  ofdma mode enabled
  Channel Freq Range 35.500 MHz to 79.500 MHz
  Channel Subcarrier Index Range Cfg: 74, 953 Op: 74, 953
  Channel SC0 Freq Cfg: 31.800 MHz Op: 31.800 MHz
  #Excl bands: 2
  (   0,   73), ( 954, 2047),
  #Unused bands: 0
  Cyclic Prefix Size 96,  Rolloff Period Size 64
  Subcarrier Spacing 50KHz,  Symbols Per Frame 18 Subcarrier Per Minislot: 8

  Modulation Profile (ID 466, Subcarrier Spacing 50KHz)
    IUC type   Cfg   Act  Preamble Bit       Pilot
               subc  subc Symbols  Loading   Pattern
    3  (IR)    64    64      4       -         -
    4  (FR)    128   128     1       -         -
    13 (data)  -     -       -     1024-QAM    2
  Calculated Data burst profile:
  IUC  Group   Bit       Pilot   Start  Consec
               Loading   Pattern Mslot  Mslot
  13   0       1024-QAM  2       0       109

  #Total mslots:110 #Fine Rng capable:95 #Initial Rng capable:103
   Initial Rng - Freq 50.000MHz mslotOffset:36 #mslot in frame:8
  Minislot mapping:  mslot#(start_sc start_freq(Mhz) end_sc end_freq(Mhz)
   mslot type(E-Edge; B-Body; S-Share with SCQAM;
   I-Initial rng capable; F-Fine rng capable)
   (next Fine Rng capable minislot if current is not capable))
  0  (  74, 35.500,   81, 35.850, EIF ( - )), 1  (  82, 35.900,   89, 36.250, BIF ( - )),
  2  (  90, 36.300,   97, 36.650, BIF ( - )), 3  (  98, 36.700,  105, 37.050, BIF ( - )),
  4  ( 106, 37.100,  113, 37.450, BIF ( - )), 5  ( 114, 37.500,  121, 37.850, BIF ( - )),
  6  ( 122, 37.900,  129, 38.250, BIF ( - )), 7  ( 130, 38.300,  137, 38.650, BIF ( - )),
  8  ( 138, 38.700,  145, 39.050, BIF ( - )), 9  ( 146, 39.100,  153, 39.450, BIF ( - )),
  10 ( 154, 39.500,  161, 39.850, BIF ( - )), 11 ( 162, 39.900,  169, 40.250, BIF ( - )),
  12 ( 170, 40.300,  177, 40.650, BIF ( - )), 13 ( 178, 40.700,  185, 41.050, BIF ( - )),
  14 ( 186, 41.100,  193, 41.450, BIF ( - )), 15 ( 194, 41.500,  201, 41.850, BIF ( - )),
  16 ( 202, 41.900,  209, 42.250, BIF ( - )), 17 ( 210, 42.300,  217, 42.650, BIF ( - )),
  18 ( 218, 42.700,  225, 43.050, BIF ( - )), 19 ( 226, 43.100,  233, 43.450, BIF ( - )),
  20 ( 234, 43.500,  241, 43.850, BIF ( - )), 21 ( 242, 43.900,  249, 44.250, BIF ( - )),
  22 ( 250, 44.300,  257, 44.650, BIF ( - )), 23 ( 258, 44.700,  265, 45.050, BIF ( - )),
```

```
24 ( 266, 45.100,  273, 45.450, BIF ( - )), 25 ( 274, 45.500,  281, 45.850, BIF ( - )),

26 ( 282, 45.900,  289, 46.250, BIF ( - )), 27 ( 290, 46.300,  297, 46.650, BIF ( - )),
28 ( 298, 46.700,  305, 47.050, BIF ( - )), 29 ( 306, 47.100,  313, 47.450, BIF ( - )),
30 ( 314, 47.500,  321, 47.850, BIF ( - )), 31 ( 322, 47.900,  329, 48.250, BIF ( - )),
32 ( 330, 48.300,  337, 48.650, BIF ( - )), 33 ( 338, 48.700,  345, 49.050, BIF ( - )),
34 ( 346, 49.100,  353, 49.450, BIF ( - )), 35 ( 354, 49.500,  361, 49.850, BIF ( - )),
36 ( 362, 49.900,  369, 50.250, BIF ( - )), 37 ( 370, 50.300,  377, 50.650, BIF ( - )),
38 ( 378, 50.700,  385, 51.050, BIF ( - )), 39 ( 386, 51.100,  393, 51.450, BIF ( - )),
40 ( 394, 51.500,  401, 51.850, BIF ( - )), 41 ( 402, 51.900,  409, 52.250, BIF ( - )),
42 ( 410, 52.300,  417, 52.650, BIF ( - )), 43 ( 418, 52.700,  425, 53.050, BIF ( - )),
44 ( 426, 53.100,  433, 53.450, BIF ( - )), 45 ( 434, 53.500,  441, 53.850, BIF ( - )),
46 ( 442, 53.900,  449, 54.250, BIF ( - )), 47 ( 450, 54.300,  457, 54.650, BIF ( - )),
48 ( 458, 54.700,  465, 55.050, BIF ( - )), 49 ( 466, 55.100,  473, 55.450, BIF ( - )),
50 ( 474, 55.500,  481, 55.850, BIF ( - )), 51 ( 482, 55.900,  489, 56.250, BIF ( - )),
52 ( 490, 56.300,  497, 56.650, BIF ( - )), 53 ( 498, 56.700,  505, 57.050, BIF ( - )),
54 ( 506, 57.100,  513, 57.450, BIF ( - )), 55 ( 514, 57.500,  521, 57.850, BIF ( - )),
56 ( 522, 57.900,  529, 58.250, BIF ( - )), 57 ( 530, 58.300,  537, 58.650, BIF ( - )),
58 ( 538, 58.700,  545, 59.050, BIF ( - )), 59 ( 546, 59.100,  553, 59.450, BIF ( - )),
60 ( 554, 59.500,  561, 59.850, BIF ( - )), 61 ( 562, 59.900,  569, 60.250, BIF ( - )),
62 ( 570, 60.300,  577, 60.650, BIF ( - )), 63 ( 578, 60.700,  585, 61.050, BIF ( - )),
64 ( 586, 61.100,  593, 61.450, BIF ( - )), 65 ( 594, 61.500,  601, 61.850, BIF ( - )),
66 ( 602, 61.900,  609, 62.250, BIF ( - )), 67 ( 610, 62.300,  617, 62.650, BIF ( - )),
68 ( 618, 62.700,  625, 63.050, BIF ( - )), 69 ( 626, 63.100,  633, 63.450, BIF ( - )),
70 ( 634, 63.500,  641, 63.850, BIF ( - )), 71 ( 642, 63.900,  649, 64.250, BIF ( - )),
72 ( 650, 64.300,  657, 64.650, BIF ( - )), 73 ( 658, 64.700,  665, 65.050, BIF ( - )),
74 ( 666, 65.100,  673, 65.450, BIF ( - )), 75 ( 674, 65.500,  681, 65.850, BIF ( - )),
76 ( 682, 65.900,  689, 66.250, BIF ( - )), 77 ( 690, 66.300,  697, 66.650, BIF ( - )),
78 ( 698, 66.700,  705, 67.050, BIF ( - )), 79 ( 706, 67.100,  713, 67.450, BIF ( - )),
80 ( 714, 67.500,  721, 67.850, BIF ( - )), 81 ( 722, 67.900,  729, 68.250, BIF ( - )),
82 ( 730, 68.300,  737, 68.650, BIF ( - )), 83 ( 738, 68.700,  745, 69.050, BIF ( - )),
84 ( 746, 69.100,  753, 69.450, BIF ( - )), 85 ( 754, 69.500,  761, 69.850, BIF ( - )),
86 ( 762, 69.900,  769, 70.250, BIF ( - )), 87 ( 770, 70.300,  777, 70.650, BIF ( - )),
88 ( 778, 70.700,  785, 71.050, BIF ( - )), 89 ( 786, 71.100,  793, 71.450, BIF ( - )),
90 ( 794, 71.500,  801, 71.850, BIF ( - )), 91 ( 802, 71.900,  809, 72.250, BIF ( - )),
92 ( 810, 72.300,  817, 72.650, BIF ( - )), 93 ( 818, 72.700,  825, 73.050, BIF ( - )),
94 ( 826, 73.100,  833, 73.450, BIF ( - )), 95 ( 834, 73.500,  841, 73.850, BI  (0  )),
96 ( 842, 73.900,  849, 74.250, BI  (0  )), 97 ( 850, 74.300,  857, 74.650, BI  (0  )),
98 ( 858, 74.700,  865, 75.050, BI  (0  )), 99 ( 866, 75.100,  873, 75.450, BI  (0  )),
100( 874, 75.500,  881, 75.850, BI  (0  )), 101( 882, 75.900,  889, 76.250, BI  (0  )),
102( 890, 76.300,  897, 76.650, BI  (0  )), 103( 898, 76.700,  905, 77.050, B   (0  )),
104( 906, 77.100,  913, 77.450, B   (0  )), 105( 914, 77.500,  921, 77.850, B   (0  )),
106( 922, 77.900,  929, 78.250, B   (0  )), 107( 930, 78.300,  937, 78.650, B   (0  )),
108( 938, 78.700,  945, 79.050, B   (0  )), 109( 946, 79.100,  953, 79.450, B   (0  )),

Mapped to connector 4 and receiver 108

Bind to Cable1/0/4 US4
MER(SNR) - Unknown - no modems online.
Spectrum Group is unassigned
Nominal Input Power Level 0 dBmV

UCD procedures on lch 0
UCD ucd-proxy-timeout   (0   ) ucd-proxy-wrong-ack (0   )
```

Configure Exclusion / Unused Bands

An OFDMA channel never uses frequencies that are located in exclusion bands. OFDMA probes are sent on frequencies that are located in the unused bands. Therefore exclusion bands must be used to prevent interference with SC-QAM channels. To configure the Exclusion / Unused Bands, follow these steps:

```
enable
configure terminal
cable upstream controller-profile id
cable ofdma-frequency-exclusion-band start-value end-value
cable ofdma-frequency-unused-band start-value end-value
```

Here is a configuration example:

```
Router# enable
Router# configure terminal
Router(config)# cable upstream controller-profile 33
Router(config-controller-profile)# cable ofdma-frequency-exclusion-band 48000000 54200000
Router(config-controller-profile)# cable ofdma-frequency-unused-band 50000000 52000000
Router(config-controller-profile)# us-channel 12 docsis-mode ofdma
Router(config-controller-profile)# us-channel 12 subcarrier-spacing 25KHz
Router(config-controller-profile)# us-channel 12 modulation-profile 423
Router(config-controller-profile)# us-channel 12 frequency-range 45000000 70000000
Router(config-controller-profile)# us-channel 12 cyclic-prefix 96 roll-off-period 64
Router(config-controller-profile)# us-channel 12 symbols-per-frame 18
```

Verify Exclusion / Unused Bands

To display the Exclusion / Unused Band configuration, use the **show controllers upstream-Cable us-channel** command as shown in the following example:

```
Router# show controllers upstream-Cable 1/0/2 us-channel 12
USPHY OFDMA support: FULL

Controller Exclusion Freq List:
( 40.000 MHz, 44.200 MHz),
Controller Unused Freq List:
( 50.000 MHz, 52.000 MHz),

Controller 1/0/9 upstream 12 AdminState:UP OpState: UP
ofdma mode enabled
Channel Freq Range 28.500 MHz to 69.500 MHz
Channel Subcarrier Index Range Cfg: 148, 1787 Op: 148, 1787
Channel SC0 Freq Cfg: 24.800 MHz Op: 24.800 MHz
#Excl bands: 3
( 0, 147), ( 608, 776), (1788, 4095),
#Unused bands: 3
( 596, 607), (1001, 1088), (1777, 1787),
```

Override OFDMA Modulation Profile Per Channel

It is possible to override the modulation and pilot pattern that is used by a particular IUC on a given OFDMA channel as shown with the following command.

```
enable
configure terminal
cable upstream controller profile id
us-channel id data-iuc id band start-value end-value modulation value pilot-pattern
 value
```

Here is a configuration example:

```
Router# enable
Router# configure terminal
```

```
Router(config)# cable upstream controller profile 33
Router(config-controller-profile)# us-channel 12 docsis-mode ofdma
Router(config-controller-profile)# us-channel 12 subcarrier-spacing 25KHz
Router(config-controller-profile)# us-channel 12 modulation-profile 423
Router(config-controller-profile)# us-channel 12 frequency-range 28000000 70000000
Router(config-controller-profile)# us-channel 12 cyclic-prefix 96 roll-off-period 64
Router(config-controller-profile)# us-channel 12 symbols-per-frame 18
Router(config-controller-profile)# us-channel 12 data-iuc 6 band 60000000 65000000 modulation
 128-QAM pilot-pattern 9
Router(config-controller-profile)# no us-channel 12 shutdown
```

Note Override values are removed from the US channel when changing modulation profile, including when the profile changes due to changes in subcarrier spacing.

Verify Override Configuration

To display the override configuration, use the **show controllers upstream-Cable us-channel** command as shown in the following example:

```
Router# show controllers upstream-Cable 1/0/2 us-channel 12
 .....
   Modulation Profile (ID 423, Subcarrier Spacing 25KHz)
    IUC type    Cfg    Act  Preamble Bit       Pilot
                subc   subc Symbols  Loading   Pattern
    3   (IR)    64     64       4       -         -
    4   (FR)    128    128      1       -         -
    6   (data)  -      -        -     1024-QAM    8
    10  (data)  -      -        -     512-QAM     8
    11  (data)  -      -        -     256-QAM     8
    12  (data)  -      -        -     128-QAM     9
    13  (data)  -      -        -     64-QAM      9
  Overwrite Data Profile:
  IUC  Start       End         Start   End    Bit       Pilot
       Freq(MHz)   Freq(MHz)   Subc    Subc   Loading   Pattern
  6      60.0       65.0       1408    1608   128-QAM   9

  Calculated Data burst profile:
  IUC  Group   Bit        Pilot   Start  Consec
               Loading    Pattern Mslot  Mslot
  6    0       1024-QAM   8       0      61
  6    1       128-QAM    9       62     11
  6    2       1024-QAM   8       74     10
  10   0       512-QAM    8       0      84
  11   0       256-QAM    8       0      84
  12   0       128-QAM    9       0      84
  13   0       64-QAM     9       0      84
 ......
```

Bind OFDMA Channel Profile to Controller

To bind OFDMA channel profile to a controller, follow this example:

```
cable virtual-service-group sg-upstream-7-0-63 upstream-cable 7/0/63 profile 1
```

```
cable rpd node1
 identifier badb.ad15.1288
 core-interface Te7/1/4
   principal
   rpd-ds 0 downstream-cable 7/0/30 profile 10
   rpd-us 1 upstream-cable 7/0/63 profile 1
```

Note We recommend using separate channel profiles to debug issues on specific RPD port.

Bind OFDMA Upstream to Cable Interface

To associate upstream channels with a MAC domain and configure upstream bonding, follow these steps:

enable
configure terminal
interface Cable *slot/subslot/interface*
upstream *id* **Upstream-Cable** *slot/subslot/interface* **us-channel** *id*
cable upstream bonding-group *id*
upstream *id*
attributes *value*
cable bundle *id*

Here is a configuration example:

```
Router# enable
Router# configure terminal
Router(config)# interface Cable 1/0/4
Router(config-if)# downstream Integrated-Cable 1/0/4 rf-channel 0
Router(config-if)# downstream Integrated-Cable 1/0/4 rf-channel 16
Router(config-if)# upstream 0 Upstream-Cable 1/0/0 us-channel 0
Router(config-if)# upstream 1 Upstream-Cable 1/0/0 us-channel 1
Router(config-if)# upstream 2 Upstream-Cable 1/0/0 us-channel 2
Router(config-if)# upstream 3 Upstream-Cable 1/0/0 us-channel 3
Router(config-if)# upstream 6 Upstream-Cable 1/0/0 us-channel 12
Router(config-if)# cable upstream bonding-group 1
Router(config-upstream-bonding)# upstream 0
Router(config-upstream-bonding)# upstream 1
Router(config-upstream-bonding)# upstream 2
Router(config-upstream-bonding)# upstream 3
Router(config-upstream-bonding)# attributes 80000000
Router(config-upstream-bonding)# exit
Router(config-if)# cable upstream bonding-group 2
Router(config-upstream-bonding)# upstream 0
Router(config-upstream-bonding)# upstream 1
Router(config-upstream-bonding)# upstream 2
Router(config-upstream-bonding)# upstream 3
Router(config-upstream-bonding)# upstream 6
Router(config-upstream-bonding)# attributes 80000000
Router(config-upstream-bonding)# exit
Router(config-if)# cable bundle 1
```

Determine DOCSIS 3.1 Cable Modems and the Cable Modems Using OFDMA Upstreams

To display the DOCSIS 3.1 cable modem, use the **show cable modem docsis version d31-capable** command as shown in the following example:

```
Router# show cable modem docsis version d31-capable
MAC Address    I/F            MAC               Reg Oper DSxUS DS   RCC   US
                              State             Ver Ver        OFDM ID    OFDMA
4800.33ea.7012 C1/0/0/UB      w-online(pt)      3.1 3.1  33x4  1    5     1
203d.66ae.4169 C1/0/0/UB      w-online(pt)      3.1 3.1  33x4  1    5     1
```

To display DOCSIS PHY layer information for the cable modem, use the **show cable modem phy** command as shown in the following example:

```
Router# show cable modem 5039.5584.5bbe phy
MAC Address    I/F        Sid   USPwr  USMER Timing DSPwr  DSMER  Mode   DOCSIS
                             (dBmV) (SNR) Offset (dBmV) (SNR)         Prov
                                    (dB)                (dB)
5039.5584.5bbe C1/0/0/U0  15    38.75  ----- 2282   0.00   -----  ofdma  1.1
```

To display the cable modem using OFDMA upstream, use the **show cable modem phy** command as shown in the following example:

```
Router# show cable modem phy | include ofdma
5039.5584.5bbe C1/0/0/U0     15    38.75  ----- 2282    0.00  -----  ofdma  1.1
0895.2a9b.26f1 C1/0/0/U0     16    28.00  ----- 2146    0.00  -----  ofdma  1.1
```

To display the OFDMA channel capacity and utilization, use the **show interface cable mac-scheduler** command as shown in the following example:

```
Router# show interfaces cable 1/0/2 mac-scheduler 6
     DOCSIS 1.1 MAC scheduler for Cable1/0/2/U6 : rate 279807192
     Max potential performance for each configured IUC type
     IUC: 6     rate: 279807192
     IUC: 10    rate: 263104848
     IUC: 11    rate: 233779840
     IUC: 12    rate: 203019328
     IUC: 13    rate: 173899376
     wfq:None
     us_balance:OFF
     dpon_mode:OFF
     fairness:OFF
     Queue[Rng Polls] flows 0
     Queue[CIR Grants] flows 0
     Queue[BE(07) Grants] flows 0
     Queue[BE(06) Grants] flows 0
     Queue[BE(05) Grants] flows 0
     Queue[BE(04) Grants] flows 0
     Queue[BE(03) Grants] flows 0
     Queue[BE(02) Grants] flows 0
     Queue[BE(01) Grants] flows 0
     Queue[BE(00) Grants] flows 0
     Req Slots 38510548
     Req/Data Slots 1275
     Init Mtn Slots 47832
     Stn Mtn Slots 0
     IUC 5 Slots 0
     IUC 6 Slots 6378
     IUC 9 Slots 0
     IUC 10 Slots 254923830
     IUC 11 Slots 220
     IUC 12 Slots 4006
```

```
IUC 13 Slots 251213508
Avg upstream channel utilization : 0%
Avg upstream channel utilization in 30 sec : 0%
Avg percent contention slots : 96%
Avg percent initial ranging slots : 0%
Avg percent minislots lost on late MAPs : 0%

MAP TSS: lch_state 10, init_retries 0
         late_initial_maps 0, late_ucd_maps 0
         mac-phy tss errors 0, missed ccc 0
```

Verify DOCSIS 3.1 Upstream OFDMA Channel Bonding Across DOCSIS 3.0 ATDMA Channels

DOCSIS 3.1 Upstream OFDMA channel can be bonded with DOCSIS 3.0 ATDMA channel. If the user wants to utilize non-best effort flows, it is recommended to bond the OFDMA channel with one or more ATDMA channels. A maximum of 1 OFDMA channel and 4 ATDMA channels can be bonded together.

Below is an output example showing the bonding group 8 has both OFDMA (channel 12) and ATDMA channels (channel 0, 1, 2, 3).

```
interface Cable6/0/0
downstream Integrated-Cable 6/0/0 rf-channel 1
downstream Integrated-Cable 6/0/0 rf-channel 158
upstream 0 Upstream-Cable 6/0/0 us-channel 0
upstream 1 Upstream-Cable 6/0/0 us-channel 1
upstream 2 Upstream-Cable 6/0/0 us-channel 2
upstream 3 Upstream-Cable 6/0/0 us-channel 3
upstream 6 Upstream-Cable 6/0/0 us-channel 12
cable upstream bonding-group 1
  upstream 0
  upstream 1
  upstream 2
  upstream 3
  attributes 80000000
cable upstream bonding-group 8
  upstream 0
  upstream 1
  upstream 2
  upstream 3
  upstream 6
  attributes 80000000
cable bundle 1
cable privacy accept-self-signed-certificate
end
```

Feature Information for DOCSIS 3.1 OFDMA Channel Configuration

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 www.cisco.com/go/cfn link. An account on the Cisco.com page is not required.

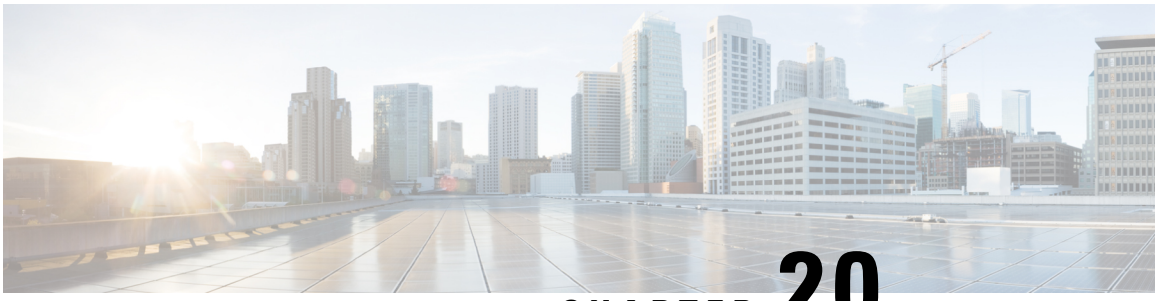
Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 41: Feature Information for DOCSIS 3.1 OFDMA Channel Configuration

Feature Name	Releases	Feature Information
Remote PHY DOCSIS 3.1 OFDMA Channel Configuration	Cisco 1x2 / Compact Shelf RPD Software 5.1	This feature was introduced on the Cisco Remote PHY Device.

PART IV

Remote PHY System Video Configuration



CHAPTER 20

Cisco Remote PHY Video Configuration

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 42: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 43: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information About R-PHY Video Configuration

The controller profile specifies the RF channels that belong to this profile and their RF parameters. Profile can either be unicast or multicast.

Multicast profile is used for downstream sharing. Multiple Remote PHY Devices (RPDs) can be configured to receive the same downstream controller. The traffic is multicast to all RPDs configured to receive the downstream controller. Applications include Video on Demand (VOD), Switched Digital Video (SDV) and Broadcast Video.

There is one principal core interface, and up to four auxiliary core interfaces in the RPD configuration. Principal core specifies the DPIC interface with which RPD connects. Auxiliary cores specify external DPIC interfaces that can be used for downstream sharing. Auxiliary core is currently used for narrowcast video, broadcast video and out-of-band data signaling path (OOB) only.

How to Configure R-PHY Video

This section describes how to configure R-PHY video on Cisco cBR-8.

Configuring Downstream Controller Profile

To configure the donwstream controller profile, use the example below:

```
Router# configure terminal
Router(config)# cable depi multicast pool 20
Router(config-multicast-pool)# ip address 225.28.0.0  255.255.0.0
Router(config-multicast-pool)# exit
Router(config)# cable downstream controller-profile 1
Router(config-controller-profile)# multicast-pool 20
Router(config-controller-profile)# rf-chan 0 15
Router(config-prof-rf-chan)# type docsis
Router(config-prof-rf-chan)# frequency 111000000
Router(config-prof-rf-chan)# rf-output normal
Router(config-prof-rf-chan)# qam-profile 1
Router(config-prof-rf-chan)# docsis-channel-id 1
Router(config-prof-rf-chan)# exit
Router(config-controller-profile)# rf-chan 16 19
Router(config-prof-rf-chan)# type video sync
Router(config-prof-rf-chan)# frequency 699000000
Router(config-prof-rf-chan)# rf-output normal
Router(config-prof-rf-chan)# qam-profile 1
Router(config-prof-rf-chan)# exit
Router(config-controller-profile)# exit
Router(config)# cable downstream controller-profile 2
Router(config-controller-profile)# multicast-pool 1
Router(config-controller-profile)# rf-chan 20 47
Router(config-prof-rf-chan)# type video sync
Router(config-prof-rf-chan)# frequency 231000000
Router(config-prof-rf-chan)# rf-output normal
Router(config-prof-rf-chan)# qam-profile 4
```

In the above example,two profiles are configured, profile 1 is a mixed profile, profile 2 is a video only profile.

Configuring RPD

To configure the RPD to include the controller profile, follow the example below:

```
Router# configure terminal
Router(config)# cable rpd RPD01
Router(config-rpd)# identifier 0004.9f31.0455
Router(config-rpd)# core-interface Te3/1/0
Router(config-rpd-core)# principal
Router(config-rpd-core)# rpd-ds 0 downstream-cable 3/0/0 profile 1
Router(config-rpd-core)# rpd-ds 0 downstream-cable 3/0/1 profile 2
Router(config-rpd-core)# rpd-us 0 upstream-cable 3/0/0 profile 1
Router(config-rpd-core)# exit
Router(config-rpd)# core-interface te6/1/0
Router(config-rpd-core)# rpd-ds 0 downstream-cable 6/0/0 profile 2
Router(config-rpd-core)# exit
Router(config-rpd)# r-dti 1
Router(config-rpd)# rpd-event profile 0
```

Note

- All channels within the profiles of a RPD must be unique, frequencies must not overlap each other.
- There must be at least one DOCSIS downstream profile in the principal core.
- Auxiliary core must only contain video and out-of-band profiles.
- A downstream controller can only be associated to one profile.

Configuring Downstream Sharing

Downstream sharing is used for multicast (MC) traffic. To configure downstream sharing, follow the example below:

```
Router# configure terminal
Router(config)# cable rpd RPD01
Router(config-rpd)# core-interface Te3/1/0
Router(config-rpd-core)# principal
Router(config-rpd-core)# rpd-ds 0 downstream-cable 3/0/1 profile 2
Router(config-rpd-core)# exit
Router(config-rpd)# exit
Router(config)# cable rpd RPD02
Router(config-rpd)# core-interface te3/1/0
Router(config-rpd-core)# principal
Router(config-rpd-core)# rpd-ds 0 downstream-cable 3/0/1 profile 2
Router(config-rpd-core)# exit
Router(config-rpd)# exit
Router(config)# cable rpd RPD03
Router(config-rpd)# core-interface te6/1/0
Router(config-rpd-core)# principal
Router(config-rpd-core)# rpd-ds 0 downstream-cable 6/0/1 profile 3
Router(config-rpd-core)# exit
Router(config-rpd)# core-interface te3/1/0
Router(config-rpd-core)# rpd-ds 0 downstream-cable 3/0/1 profile 2
```

Note All RPDs in the same multicast group have the same controller and profile association.

Configuring Video

To configure Video, see Cisco Converged Broadband Routers Video Configuration Guide for Cisco IOS XE Everest 16.5.1.

Configuring Virtual Service Group

Virtual Service Group is supported to allow the controller configuration and removal of an RPD using that controller without removing the video configuration. To configure virtual service group, follow the example below:

1. Add controller profile:

```
Router(config)# cable downstream controller-profile 2
Router(config-controller-profile)# multicast-pool 20
Router(config-controller-profile)# rf-channel 20 47
Router(config-prof-rf-chan)# type video sync
Router(config-prof-rf-chan)# frequency 231000000
Router(config-prof-rf-chan)# rf-output NORMAL
Router(config-prof-rf-chan)# qam-profile 7
Router(config-prof-rf-chan)# exit
Router(config-controller-profile)# exit
```

2. Assign controller profile to a downstream cable for a virtual service group:

```
Router(config)# cable virtual-service-group VOD_SG1801 downstream-cable 9/0/1 profile 2
Router(config)# cable virtual-service-group VOD_SG1802 downstream-cable 9/0/3 profile 2
Router(config)# cable virtual-service-group BC_Chicago downstream-cable 9/0/31 profile
3
```

3. Create VCG, SDG, RPD downstream cable, bind VCG to SDG, assign VCG to LED, set LED active, and create sessions:

```
Router(config)# cable video
Router(config-video)# multicast-uplink Port-channel22 access-list all-multicasts
Router(config-video)# mgmt-intf VirtualPortGroup 0
Router(config-video)# service-distribution-group sdg91 id 91
Router(config-video-sdg)# rpd downstream-cable 9/0/1
Router(config-video-sdg)# exit
Router(config-video)# virtual-carrier-group vcg91 id 91
Router(config-video-vcg)# encrypt
Router(config-video-vcg)# service-type narrowcast
Router(config-video-vcg)# rf-channel 40-63 tsid 38001-38024 output-port-number 1-24
Router(config-video-vcg)# exit
Router(config-video)# bind-vcg
Router(config-video-bd)# vcg vcg91 sdg sdg91
Router(config-video-bd)# exit
Router(config-video)# logical-edge-device led-1 id 1
Router(config-video-led)# protocol table-based
Router(config-video-led-protocol)# virtual-edge-input-ip 174.102.1.1 input-port-number
1
Router(config-video-led-protocol)# vcg vcg91
Router(config-video-led-protocol)# active
Router(config-video-led-protocol)# table-based
Router(config-video-tb)# vcg vcg91
Router(config-video-tb-vcg)# rf-channel 40
Router(config-video-tb-vcg-sess)# session ss group 232.2.1.251 source 175.2.3.2
processing-type remap
```

4. Assign controller to RPD, then physical QAM id is allocated and video sessions are online:

```
Router(config)# cable rpd RPD01
Router(config-rpd)# identifier 0004.9f32.1573
Router(config-rpd)# core-interface Te9/1/0
Router(config-rpd-core)# principal
Router(config-rpd-core)# rpd-ds 0 downstream-cable 9/0/1 profile 2
Router(config-rpd-core)# rpd-ds 0 downstream-cable 9/0/3 profile 2
Router(config-rpd-core)# rpd-us 0 upstream-cable 9/0/0 profile 1
Router(config-rpd-core)# exit
Router(config-rpd)# core-interface Te9/1/6
Router(config-rpd-core)# rpd-ds 0 BC_Chicago
Router(config-rpd-core)# exit
Router(config-rpd)# r-dti 1
Router(config-rpd)# rpd-event profile 0
```

5. It is allowed to remove or replace the controller from the RPD configuration as show below, without touching any video configuration, then the video sessions are in off state which is similar to the scenario that the video QAM is shut down.

```
Router(config)# cable rpd RPD01
Router(config-rpd)# core-interface Te9/1/0
Router(config-rpd-core)# no rpd-ds 0 downstream-cable 9/0/1 profile 2
```

Note If virtual service group doesn't exist while adding controller downstream to RPD configuration, virtual service group is automatically generated when the controller profile has one or more rf-channels of the video type. If the user changes RPD downstream configuration to use another controller profile different from the one in virtual service group and in the meantime video configuration exists, the user also needs to update the controller profile in the virtual service group for that downstream as well, otherwise all the video sessions will be down.

Example: R-PHY Video Configuration

The following example shows how to configure Remote-PHY video:

```
Router# configure terminal
Router(config)# cable downstream qam-profile 7
Router(config-qam-prof)# annex B modulation 256
Router(config-qam-prof)# interleaver-depth I32-J4
Router(config-qam-prof)# symbol-rate 5361
Router(config-qam-prof)# spectrum-inversion off
Router(config-qam-prof)# description default-annex-b-256-qam
Router(config-qam-prof)# exit
Router(config)# cable depi multicast pool 20
Router(config-multicast-pool)# ip address 225.28.0.0 255.255.0.0
Router(config-multicast-pool)# exit
Router(config)# cable downstream controller-profile 1
Router(config-controller-profile)# multicast-pool 20
Router(config-controller-profile)# rf-channel 0 15
Router(config-prof-rf-chan)# type docsis
Router(config-prof-rf-chan)# frequency 111000000
Router(config-prof-rf-chan)# rf-output NORMAL
Router(config-prof-rf-chan)# qam-profile 7
Router(config-prof-rf-chan)# docsis-channel-id 1
Router(config-prof-rf-chan)# exit
Router(config-controller-profile)# exit
Router(config)# cable downstream controller-profile 2
Router(config-controller-profile)# multicast-pool 20
Router(config-controller-profile)# rf-channel 20 47
Router(config-prof-rf-chan)# type video sync
Router(config-prof-rf-chan)# frequency 231000000
Router(config-prof-rf-chan)# rf-output NORMAL
Router(config-prof-rf-chan)# qam-profile 7
Router(config-prof-rf-chan)# exit
Router(config-controller-profile)# exit
Router(config)# cable rpd RPD01
Router(config-rpd)# identifier 0004.9f31.0979
Router(config-rpd)# core-interface te6/1/0
Router(config-rpd-core)# principal
Router(config-rpd-core)# rpd-ds 0 downstream-cable 6/0/0 profile 1
Router(config-rpd-core)# rpd-ds 0 downstream-cable 6/0/1 profile 2
Router(config-rpd-core)# rpd-us 0 upstream-cable 6/0/0 profile 1
```

```
Router(config-rpd-core)# exit
Router(config-rpd)# r-dti 6
Router(config-rpd)# rpd-event profile 0
Router(config-rpd)# exit
Router(config)# cable rpd RPD2
Router(config-rpd)# identifier 0004.9f31.1437
Router(config-rpd)# core-interface Te3/1/0
Router(config-rpd-core)# principal
Router(config-rpd-core)# rpd-ds 0 downstream-cable 3/0/0 profile 1
Router(config-rpd-core)# rpd-us 0 upstream-cable 3/0/0 profile 1
Router(config-rpd-core)# exit
Router(config-rpd)# core-interface Te6/1/0
Router(config-rpd-core)# rpd-ds 0 downstream-cable 6/0/1 profile 2
Router(config-rpd-core)# exit
Router(config-rpd)# r-dti 3
Router(config-rpd)# rpd-event profile 0
Router(config-rpd)# exit
Router(config)# cable video
Router(config-video)# service-distribution-group RPD_SDG
Router(config-video-sdg)# rpd downstream-cable 6/0/1
Router(config-video-sdg)# exit
Router(config-video)# virtual-carrier-group RPC_VCG
Router(config-video-vcg)# rf-channel 20-47 tsid 20-47 output-port-number 20-47
Router(config-video-vcg)# exit
Router(config-video)# bind-vcg
Router(config-video-bd)# vcg RPC_VCG sdg RPD_SDG
Router(config-video-bd)# exit
Router(config-video)# logical-edge-device RPD_LED
Router(config-video-led)# protocol table-based
Router(config-video-led-protocol)# virtual-edge-input-ip 174.102.1.1 input-port-number 1
Router(config-video-led-protocol)# vcg RPD_VCG
Router(config-video-led-protocol)# active
Router(config-video-led-protocol)# table-based
Router(config-video-tb)# vcg RPD_VCG
Router(config-video-tb-vcg)# rf-channel 20-47
Router(config-video-tb-vcg-sess)# session tbsession-1 input-port 1 start-udp-port 49152
num-sessions-per-qam 20 processing-type remap start-program 1 bit-rate 1800000
```

Feature Information for Remote PHY Video

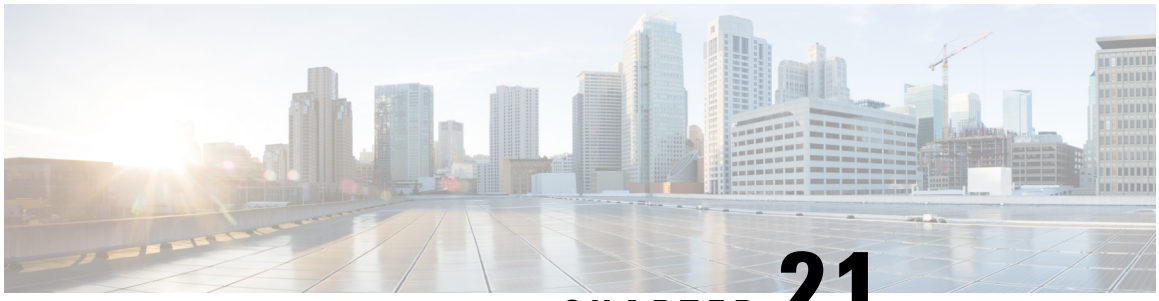
The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train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

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

Table 44: Feature Information for Remote PHY Video

Feature Name	Releases	Feature Information
RPHY Video PME VOD	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.
RPHY Video Pre-Encrypted MPTS Pass-Thru Support	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.

Feature Name	Releases	Feature Information
RPHY Pre-encrypted Broadcast Video Support	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.



CHAPTER 21

Remote PHY DVB Video on Demand

The Digital Video Broadcasting (DVB) protocol for encrypting video services as defined in the ETSI TS 103 197 DVB Simulcrypt specification has been implemented on the line card for DVB R-PHY on Cisco cBR-8. This document contains an overview of the commands for configuring DVB and the commands for viewing the status of the encryption of services.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Information About DVB VOD

Overview of DVB VOD

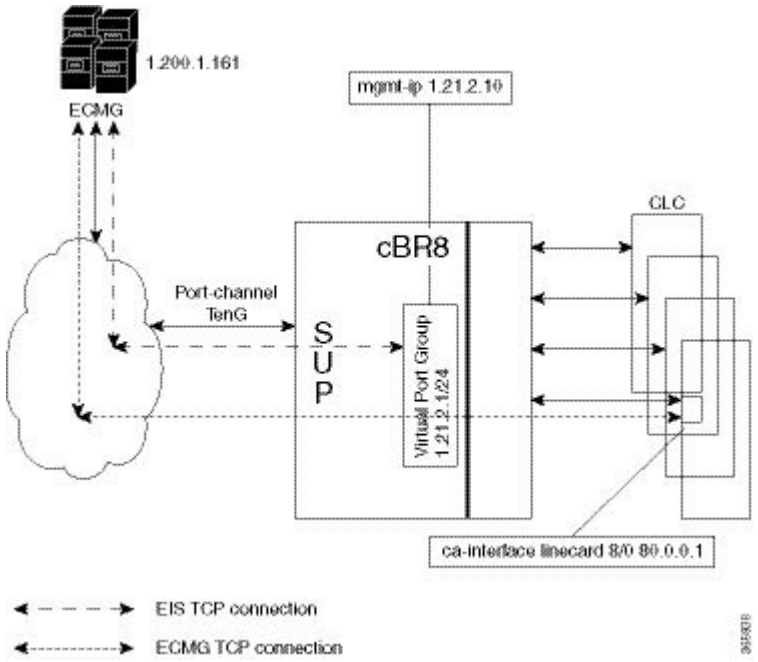
This feature enables the operator to scramble the video sessions on the chassis. It involves the configuration to establish a connection with the Entitlement Control Message Generator (ECMG) and the Event Information Scheduler (EIS).

The two primary modes of scrambling are: session based scrambling and tier-based scrambling. The basic difference between the two modes is that the manner in which the Entitlement Control Messages (ECM) are requested from the ECMG. For session based scrambling, a control word (CW) is generated once every Crypto Period (CP) and the ECM is requested for each session. For tier-based scrambling, the control word is generated once every CP and the ECM generated by the ECMG for the CW is used by all the sessions in the chassis.

Session based Scrambling Setup

The connection with the external EIS Server is established via the Virtual Port Group in the Supervisor. The connection with the external ECMG server is established via the linecard.

Figure 9: Session based Setup



Fail-to-Clear

The fail-to-clear-duration feature is supported on DVB sessions and DualCrypt encryption modes. Based on the session encryption, the following two features are supported on the Cisco cBR Series Converged Broadband Routers.

Fail-to-Clear Duration for DVB Session-based Encryption

This feature is used along with DVB or DualCrypt encryption with external Event Information Scheduler (EIS) configuration. When encryption for a session fails in the Cisco cBR-8, this feature enables the operator to control the configured DVB-encrypted sessions to function without encryption for a configured duration. If the encryption still fails, the DVB session is marked as `Fail-to-black` after the fail-to-clear duration timeout.

Fail-to-Clear for DVB Tier-based Encryption

This feature is used along with Tier-based configuration. When encryption for a session fails in Cisco cBR-8, this feature enables the operator to control the configured DVB-encrypted sessions to function without encryption.

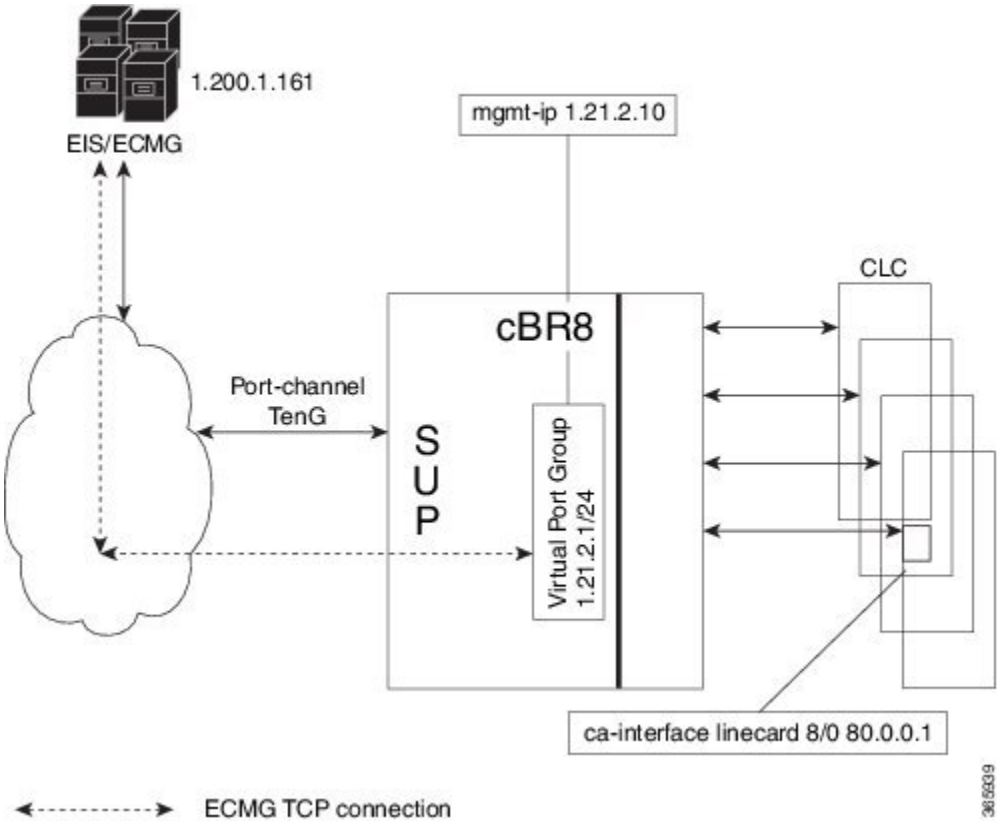
If fail-to-clear is configured, tier-based configuration is enabled, and then if the encryption fails, the DVB session's `Encrypt Status` is marked as `clear`. The status changes to `Encrypted` when the encryption starts.

This feature is not enabled by default.

Tier based Scrambling Setup

The connection with the external ECMG server is established via the Virtual Port Group in the Supervisor.

Figure 10: Tier based Setup



Restrictions for DVB

- This feature is applicable only for remapped table based sessions.
- Fail-to-clear-duration feature is applicable only to session-based scrambling for DVB CAS encryption.
- Fail-to-clear feature is applicable only to DVB tier-based scrambling sessions.

How to Configure DVB

Configuring RPHY DVB VoD

Before You Begin

- Virtual Port Group interface must be configured and the management IP for DVB must be identified.
- Management interface is set to this Virtual Port Group interface under cable video configuration.

- Logical Edge Device is configured with the table based protocol.
- The encryption algorithm of the linecard is set to DVB-CSA.
- For session based scrambling, the CA interface on the linecard and the route for reaching the ECMG server must be specified.

To configure session based scrambling, follow the steps below:

```
enable
config terminal
  interface int_id
    vrf forwarding vrf_script_red_1
    ip address ip-address subnet-mask
    no mop enabled
    no mop sysid
    exit
  cable video
    mgmt-intf VirtualPortGroup group_id
    encryption
      linecard slot/bay ca-system dvb scrambler dvb-csa
      dvb
        route-ecmg ECMG_Server_IP_Address Netmask Interface Forwarding_Router_IP_Address
        mgmt-ip management ip address
        eis EIS_name id EIS_id
          listening-port <1-65535> bind led id <led id | led name>
        ca-interface linecard slot/bay IP_Address
        ecmg ECMG_Name id ECMG_ID
          mode vod linecard slot/bay
          type standard
          ca-system-id CA_System_ID CA_Subsystem_ID
          auto-channel-id
          ecm-pid-source sid
          connection id ID priority connection_priority IP_Address Port
    service-distribution-group sdg name id SDG ID onid onid number
      rpd downstream-cable slot/subslot/bay
    virtual-carrier-group vcg-name id vcg_id
      encrypt
      service-type narrowcast
      rf-channel channel tsid tsid_number output-port-number number
    bind-vcg
      vcg vcg-name sdg sdg-name
    logical-edge-device led-name id led_id
      protocol gqi
        mgmt-ip IP_Address
        mac-address MAC address
        server server_ip_address
        keepalive retry 3 interval 10
        reset interval 8
        virtual-edge-input-ip IP address input-port-number 1
        vcg vcg-name
        active
```

The fail-to-clear-duration is measured in seconds. The valid values are in the range from 0 to 10800 seconds. The default value is 0.

To configure tier based scrambling, follow the steps below:

```
enable
config terminal
  interface VirtualPortGroup group_id
    vrf forwarding Mgmt-intf
    ip address ip-address subnet-mask
```

```
    no mop enabled
    no mop sysid
    exit

  cable video
    mgmt-intf VirtualPortGroup group_id
    encryption
      linecard slot/bay ca-system dvb scrambler dvb-csa
      dvb
        route-ecmg ECMG_Server_IP_Address Netmask Interface Forwarding_Router_IP_Address
        ecmg ECMG_Name id ECMG_ID
          mode tier-based
          type standard
          ca-system-id CA_System_ID CA_Subsystem_ID
          auto-channel-id
          ecm-pid-source sid
          connection id ID priority connection_priority IP_Address Port
        tier-based
          ecmg id ECMG_ID access- criteria access_criteria_in_hex
          fail-to-clear
          enable
    service-distribution-group sdg name id SDG ID onid onid number
      rpd downstream-cable slot/subslot/port
    virtual-carrier-group vcg-name id vcg_id
      encrypt
      service-type narrowcast
      rf-channel channel tsid tsid_number output-port-number number
    bind-vcg
      vcg vcg-name sdg sdg-name
    logical-edge-device led-name id led_id
      protocol table-based
        virtual-edge-input-ip IP address input-port-number 1
        vcg vcg-name
        active
    table-based
      vcg vcg-name
        rf-channel channel
          session session_name input-port id start-udp-port udp port number processing-type
 remap start-program 1 cbr
```

Note If the tier-based configuration is already enabled, you must first disable the tier-based configuration using the **no enable**, before you configure fail-to-clear feature.

Verifying the DVB Configuration

To verify the configuration of the encryption algorithm on the linecard, use the **show cable video encryption linecard** command as shown in the example below:

```
Router# show cable video encryption linecard 7/0
Line card: 7/0
CA System       Scrambler       DVB-Conformance
================================================
dvb             dvb-csa         Enabled
```

To verify the ECMG connection, use the **show cable video encryption dvb ecmg id** *id* **connection** command as shown in the example below:

```
Router# show cable video encryption dvb ecmg id 1 connection
------------------------------------------------------------------------------------------------------
ECMG ECMG           ECMG     CA Sys CA Subsys PID    Lower Upper Streams/ Open Streams/
Auto Chan Slot ECMG        ECMG
ID   Name           Type     ID     ID        Source limit limit ECMG     ECMG          ID
             Connections Application
------------------------------------------------------------------------------------------------------
1    polaris_ecmg01 standard 0x4748 0x0       sid    0     0     1        1
Enabled   RP   1           Tier-Based

ECMG Connections for ECMG ID = 1

-----------------------------------------------------------
Conn Conn     IP          Port    Channel  Conn    Open
-ID  Priority Address     Number  ID       Status  Streams
-----------------------------------------------------------
1    1        10.10.1.1  8888    1        Open    1
```

The sample output of the session based scrambling configuration verification command is shown below:

```
Router# show cable video encryption dvb ecmg id 7 connection
------------------------------------------------------------------------------------------------------
ECMG ECMG           ECMG     CA Sys CA Subsys PID    Lower Upper Streams/ Open Streams/
Auto Chan Slot ECMG        ECMG
ID   Name           Type     ID     ID        Source limit limit ECMG     ECMG          ID
             Connections Application
------------------------------------------------------------------------------------------------------
7    ecmg-7         standard 0x950  0x1234    sid    0     0     1680     1680
Enabled   7    1           VOD

ECMG Connections for ECMG ID = 1

-----------------------------------------------------------
Conn Conn     IP          Port    Channel  Conn    Open
-ID  Priority Address     Number  ID       Status  Streams
-----------------------------------------------------------
1    1        10.10.1.10  8888    1        Open    1
```

The status of the connection with the ECMG Server is indicated by the Conn Status. The Open Streams field indicates the number of Active ECM Streams.

To verify the EIS connection, use the **show cable video encryption dvb eis id** *id* command as shown in the example below:

```
Router# show cable video encryption dvb eis id 1
-------------------------------------------------------------------------------------------
EIS EIS  Peer       Management TCP  CP       CP       Overwrite Fail-To-Clear Connection
ID  Name IP         IP         Port Overrule Duration SCG       Duration      Status
-------------------------------------------------------------------------------------------
1   test 10.10.1.11 10.10.1.1  9898 DISABLED 0        DISABLED  400           Connected
```

To verify the CA Interface configuration in the case of session based scrambling, use the **show cable video encryption dvb ca-interface brief** command as shown in the example below:

```
Router# show cable video encryption dvb ca-interface brief
CA Interface configuration

------------------------------
Linecard    IP Address    VRF
------------------------------
7           10.10.1.1     N/A

ECMG Route configuration

-----------------------------------------------------
```

```
IP Address    NetMast         Interface
-----------------------------------------------------
10.10.1.10    255.255.255.224   TenGigabitEthernet4/1/2
```

To verify the encryption status of the sessions, use the **show cable video session logical-edge-device id** command as shown in the example below:

```
Router# show cable video session logical-edge-device id 1
Total Sessions = 1

Session Output Streaming Session Session Source               UDP   Output  Input
Output Input   Output  Encrypt Encrypt   Low     Session
Id      Port   Type      Type    Ucast Dest IP/Mcast IP (S, G) Port  Program State
State  Bitrate Bitrate Type    Status    Latency Name
-------------------------------------------------------------------------------------------------------------
1048576 1      Remap     UDP     10.10.1.1                   49167 20      ACTIVE-PSI
   1695161 1689747 DVB     Encrypted N       dvbsess.1.0.1.0.23167
```

To verify the ECM PID and whether the CA Descriptor is added to the PMT, use the **show cable video session logical-edge-device id session-id** command as shown in the example below:

```
Router# show cable video session logical-edge-device id 1 session-id 1048576
Output PMT Info:
==============================
  Program 20, Version 3, PCR 49, Info len 18,  (CA SYS-ID 4748, PID 79)
  PID 49: Type 2, Info len 0
  PID 50: Type 3, Info len 6, (lang eng)
```

Troubleshooting Tips

If some configuration errors occur, see the following troubleshooting tips:

- The Management IP must be unique and in the subnet of virtual port group.
- Ensure that the ECMG Server is pingable with source interface as the virtual port group from the Cisco cBR-8 console. This indicates that the ECMG Server is reachable and route is valid.
- Ensure that the TCP port number configured for the ECMG Server in the Cisco cBR-8 is the same as that of the ECMG Server listening port.
- Ensure that the management IP is pingable from the EIS Server. Otherwise, check the routing between the cBR-8 chassis and the EIS server.
- Ensure that the listening port that is configured for the EIS is used for establishing the connection from the EIS Server.
- Ensure that the Virtual Port Group interface is active.
- Ensure that the TenGigabitEthernet interface using which the management traffic reaches the Cisco cBR-8 and the interface through which the CA interface route is configured are active.

Configuration Examples

This section provides examples for the DVB configuration.

Example: Basic Session-based Scrambling Configuration

```
enable
config terminal
  interface VirtualPortGroup0
    vrf forwarding vrf_script_red_1
    ip address 10.10.1.1 255.255.255.224
    no mop enabled
    no mop sysid
    exit
  cable video
    mgmt-intf VirtualPortGroup 0
    encryption
      linecard 7/0 ca-system dvb scrambler dvb-csa
      dvb
        route-ecmg 10.20.1.1 255.255.255.224 TenGigabitEthernet4/1/2 10.20.1.1
        mgmt-ip 10.10.1.2
        eis eis-1 id 1
          listening-port 8890 bind led id 1
        ca-interface linecard 7/0 10.30.1.1
        ecmg ecmg-7 id 7
          mode vod linecard 7/0
          type standard
          ca-system-id 950 1234
          auto-channel-id
          ecm-pid-source sid
          connection id 1 priority 1 10.20.1.3 8888
    service-distribution-group sdg-1 id 1 onid 1
      rpd downstream-cable 7/0/1
    virtual-carrier-group vcg-1 id 1
      encrypt
      service-type narrowcast
      rf-channel 0 tsid 1 output-port-number 1
    bind-vcg
      vcg vcg-1 sdg sdg-1
    logical-edge-device led-1 id 1
      protocol table-based
      virtual-edge-input-ip 192.0.2.0 input-port-number 1
      vcg vcg-1
      active
    table-based
      vcg vcg-1
    rf-channel 0
    session dvb-1 input-port 1 start-udp-port 49152 processing-type
remap start-program 1 cbr
```

Example: Basic Tier-based Scrambling Configuration

```
enable
config terminal
  interface VirtualPortGroup0
    vrf forwarding vrf_script_red_1
    ip address 10.10.1.1 255.255.255.224
    no mop enabled
    no mop sysid
    exit
  cable video
    mgmt-intf VirtualPortGroup 0
    encryption
      linecard 7/0 ca-system dvb scrambler dvb-csa
      dvb
```

```
      route-ecmg 10.20.1.0 255.255.255.224 TenGigabitEthernet4/1/2 10.20.1.1
      ecmg ecmg-7 id 7
        mode tier-based
        type standard
        ca-system-id 950 1234
        auto-channel-id
        ecm-pid-source sid
        connection id 1 priority 1 10.20.1.3 8888
      tier-based
        ecmg id 7 access-criteria 1122334455
        fail-to-clear
        enable
  service-distribution-group sdg-1 id 1 onid 1
    rpd downstream-cable 7/0/1
  virtual-carrier-group vcg-1 id 1
    encrypt
    service-type narrowcast
    rf-channel 0 tsid 1 output-port-number 1
  bind-vcg
    vcg vcg-1 sdg sdg-1
  logical-edge-device led-1 id 1
    protocol table-based
      virtual-edge-input-ip 192.0.2.0 input-port-number 1
      vcg vcg-1
      active
  table-based
    vcg vcg-1
      rf-channel 0
       session dvb-1 input-port 1 start-udp-port 49152 processing-type remap start-program
1 cbr
```

Example: Basic Session-based Dualcrypt Scrambling Configuration

```
enable
config terminal
  interface VirtualPortGroup0
    vrf forwarding vrf_script_red_1
    ip address 10.10.1.1 255.255.255.224
    no mop enabled
    no mop sysid
    exit
  cable video
    mgmt-intf VirtualPortGroup 0
    encryption
      linecard 7/0 ca-system dvb scrambler dvb-csa
      dvb
        route-ecmg 10.20.1.0 255.255.255.224 TenGigabitEthernet4/1/2 10.20.1.1
        mgmt-ip 10.10.1.2
        eis eis-1 id 1
          listening-port 8890 bind led id 1
        ca-interface linecard 7/0 10.30.1.1
        ecmg ecmg-7 id 7
          mode vod linecard 7/0
          type standard
          ca-system-id 950 1234
          auto-channel-id
          ecm-pid-source sid
          connection id 1 priority 1 10.20.1.3 8888
    service-distribution-group sdg-1 id 1 onid 1
      rpd downstream-cable 7/0/1
    virtual-carrier-group vcg-1 id 1
      encrypt
      service-type narrowcast
      rf-channel 0 tsid 1 output-port-number 1
```

```
bind-vcg
  vcg vcg-1 sdg sdg-1
logical-edge-device led-1 id 1
  protocol gqi
    mgmt-ip 10.10.1.3
    mac-address xxxx.yyyy.zzzz
    server 10.20.1.2
    keepalive retry 3 interval 10
    reset interval 8
    virtual-edge-input-ip 192.0.2.0 input-port-number 1
    vcg vcg-1
    active
```

Additional References

Related Documents

Related Topic	Document Title
Configuring Tier-Based Scrambling	*Cisco RF Gateway 10 Software Configuration Guide*

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

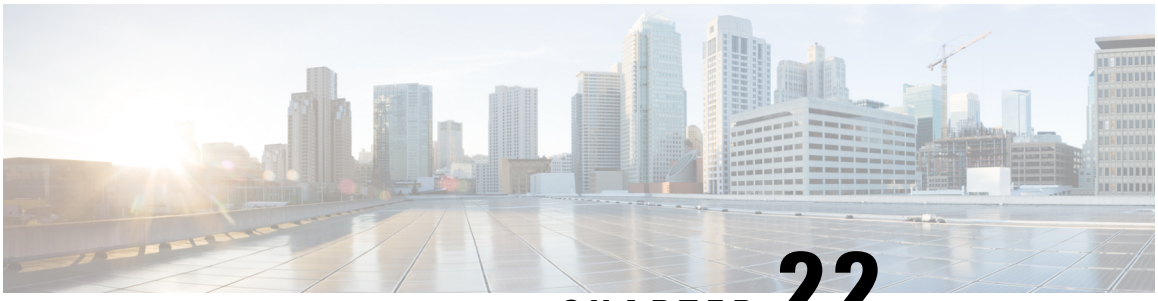
Feature Information for RPHY DVB VoD Suppot

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 www.cisco.com/go/cfn 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 45: Feature Information for RPHY DVB VoD Suppot

Feature Name	Releases	Feature Information
RPHY DVB VoD Support	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was introduced on the Cisco Remote PHY Device.



CHAPTER 22

Cisco Remote PHY PowerKEY VOD

PowerKEY Video-on-Demand refers to video content that is chosen by the subscriber and streamed specifically to the subscriber. The content is encrypted using PowerKEY conditional access through a video session that is created on the line card in R-PHY mode on Cisco cBR-8, specifically for each request.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 46: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information About PowerKEY VOD

The line cards in R-PHY mode on Cisco cBR-8 supports session-based PowerKey VOD. In both RPHY and integrated modes, the Cisco cBR-8 router establishes a GQI Remote Procedure Call (RPC) connection to the Edge Resource Manager (SRM), which may be an Explorer Controller (EC), USRM, or any other session manager. The Cisco cBR-8 supports 40G-R line cards, which can be configured for RPHY.

Configure the PowerKey VOD carriers in a GQI protocol LED. The Virtual Carrier Groups (VCG) in the LED, must be bound to a Service Distribution Group (SDG) with downstream-cable ports (instead of the integrated-cable ports).

Overview of PowerKEY VoD

PowerKEY VOD allows the operator to provide secure, encrypted video streams to a particular subscriber over the RF plant. PowerKEY video-on-demand is used in a Cisco cable environment to provide edge-encrypted video-on-demand movies and other content to subscribers. A subscriber can select the content through an on-screen selection and the set-top box (STB) notifies the head-end of the request.

The head-end equipment receives the request from the STB and triggers the Session Resource Manager (SRM) to create an encrypted video session on the Cisco cBR-8. At the same time, the video streamer is triggered to begin streaming the content in a UDP stream to the Cisco cBR-8. The Cisco cBR-8 receives an unscrambled

video content, encrypts it using PowerKEY, combines the scrambled stream with other content intended for the RF carrier into a Multi-Program Transport Stream (MPTS), encapsulates it using R-DEPI protocol, and sends it out on Ethernet port to the Converged Interconnect Network (CIN) between the cBR-8 RPHY core and the RPHY Device (RPD).

How to Configure RPHY PowerKey VOD

Note To know more about the commands referenced in this section, see the Cisco IOS Master Command List.

Configuring the Encryption Type on the Line Card

The Cisco IOS-XE supports PowerKey encryption CA systems, but allows only one encryption type to be installed on the line card. There are two levels in the CA system. The lower level scrambler, which encrypts the actual data streams and the upper level conditional access system, which handles how the control words are transferred from the encrypting device to the decrypting device.

To specify the type of encryption used to scramble the data streams, complete the following procedure:

```
configure terminal cable video encryption
linecard slot/bay ca-system [powerkey] scrambler scrambler-type
exit
```

PowerKey currently supports DES type of encryption.

Verifying the Encryption Configuration

To verify the encryption type of a line card, use the show cable video encryption linecard command as shown in the following example:

```
show cable video encryption linecard 7/0
Line card: 7/0
CA System Scrambler
================================
powerkey des
```

Configuring the Encrypted Virtual Carrier Groups

For the sessions to be encrypted on the Cisco cBR-8, the Virtual Carrier Groups (VCGs) must be specified as encrypt and the line card must be configured as encrypted. In this way, the operator can choose the carriers on the line card that support encryption and other carriers that support only clear or pre-encrypted sessions. Each encrypted carrier consumes an encrypted carrier license.

For the VCG to be used in a Logical Edge Device (LED) that is configured with the GQI protocol, each RF carrier must be assigned with an output port number. The LED must be configured with the Generic QAM Interface (GQI) protocol in order to support session-based operation.

Note For PowerKEY VOD, you have to specify the session-based operation.

To configure the VCG, complete the following procedure:

```
configure terminal cable video
virtual-carrier-group vcg-name
encrypt
rf-channel channel range tsid tsid range output-port-number port num range
exit
```

Configuring the Encrypted Virtual Carrier Groups

For the sessions to be encrypted on the Cisco cBR-8, the Virtual Carrier Groups (VCGs) must be specified as **encrypt** and the line card must be configured as encrypted. In this way, the operator can choose the carriers on the line card that support encryption and other carriers that support only clear or pre-encrypted sessions. Each encrypted carrier consumes an encrypted carrier license.

For the VCG to be used in a Logical Edge Device (LED) that is configured with the GQI protocol, each RF carrier must be assigned with an output port number. The LED must be configured with the Generic QAM Interface (GQI) protocol in order to support session-based operation.

Note For PowerKEY VOD, you have to specify the session-based operation.

To configure the VCG, complete the following procedure:

```
configure terminal
cable video
virtual-carrier-group vcg-name
rf-channel channel range tsid tsid range output-port-number port num range
virtual-edge-input ip-address [vrf] vrf name input-port-number number
encrypt
exit
```

Verifying the Encrypted Virtual Carrier Groups Configuration

To verify the encrypted VCGs configuration, use the **show cable video virtual-carrier-group name** command as shown in the example below:

```
show cable video virtual-carrier-group name vod-grp
```

Configuring the Service Distribution Groups and Binding

The Service Distribution Group (SDG) is a collection of one or more RF ports and defines the physical slot/bay/port to be used in a video service. After you configure an SDG, you can bind a VCG to an SDG. The binding connects the carriers defined in the VCG to the physical port listed in the SDG. After binding, a path from the Virtual Edge Input (VEI) is mapped to the RF channels.

The following example shows how to configure the SDGs and binding:

```
configure terminal cable video
  mgmt-intf VirtualPortGroup 0

service-distribution-group sdg1 id 1
    rpd downstream-cable 7/0/0
virtual-carrier-group vcg1 id 1
    service-type narrowcast
    encrypt
    rf-channel 0-10 tsid 1-11 output-port-number 1-11

bind-vcg
    vcg vcg1 sdg sdg1
```

Configuring the Logical Edge Device and GQI Protocol

The PowerKEY VOD feature on the Cisco cBR-8 is directed by an external Session Resource Manager (SRM) that creates video sessions in response to a subscriber selecting VOD content to watch on the set top box. You must configure a Logical Edge Device (LED) supporting the GQI protocol on the Cisco cBR-8 to support the PowerKEY VOD.

The LED is configured with the GQI protocol as the LED communicates with an external SRM using the GQI protocol. The GQI protocol supports the creation and deletion of sessions on the carriers owned by this LED.

Note Use the following command to get the chassis MAC address:

```
Router#show diag all eeprom detail | include MAC
Chassis MAC Address : 54a2.740e.2000
MAC Address block size : 1024
```

Using the Chassis MAC as a basis, increment the least significant number to give a unique identifier (mac-address) for each LED. This number needs to be unique with respect to the GQI server and does not really relate to a true MAC address. Thus, the number is irrelevant, but needs to be unique.

To configure the Logical Edge Device and GQI Protocol, complete the following procedure:

```
cable video
logical-edge-device led1 id 1
    protocol gqi
      mgmt-ip management ip address
      mac-address mac address from this chassis range
      server ip address of srm
      keepalive retry 3 interval 10
      reset interval 8
      virtual-edge-input-ip ip addr for content input-port-number num
      vcg virtual edge qam name (may be multiple vcgs in an LED)
      active
```

Verifying the PowerKEY VoD Configuration

The PowerKEY encrypted VOD LED is active and communicates with the external SRM device after configuring the encryption type on the line card, VCGs, binding of SDGs, and LED with GQI protocol are completed.

To verify the Logical Edge Device configuration, use the show cable video logical-edge-device name led name command or the show cable video logical-edge-device id led number command as shown in the example below:

```
show cable video logical-edge-device name pkvodled
Logical Edge Device: pkvodled
Id: 1
Protocol: gqi
Service State: Active
Discovery State: Disable
Management IP: 1.23.2.10
MAC Address: 54a2.740d.dc99
Number of Servers: 1
Server 1: 1.200.3.75
Reset Interval: 8
Keepalive Interval: 10
Retry Count:3
Number of Virtual Carrier Groups: 1
Number of Share Virtual Edge Input: 1
Number of Physical Qams: 20
Number of Sessions: 0
No Reserve PID Range
Virtual Edge Input:
Input Port  VEI        Slot/Bay  Bundle  Gateway
ID    IP       ID     IP
----------------------------------------------------------------
1          174.10.2.1   7/0 - -
```

Verify the following:

- The service state of the LED should be active and the other fields must be same as the configured values.
- The connection to the remote SRM should be displayed to ensure that there is a valid network connection to the SRM.
- Execute the show cable video gqi connections command. The following is the sample output when the connection is not established to the SRM:

  ```
  LED Management  Server    Connection     Version Event   Reset       Encryption
  ID  IP    IP  Status           Pending Indication  Discovery
  ------------------------------------------------------------------------------
  1   1.23.2.10  1.200.3.75 Not Connected  0 0        Not Sent     Not Sent
  ```

  The following is the sample output when the connection is established to the SRM:

  ```
  LED Management Server      Connection     Version Event    Reset      Encryption
  ID  IP   IP    Status           Pending  Indication Discovery
  ------------------------------------------------------------------------------
  1   1.23.2.10  1.200.3.75  Not Connected  2 0   ACKED ACKED
  ```

  After the connection is established, the SRM may create encrypted sessions on the carriers of the LED.

- To view the encrypted sessions, use the show cable video session logical-edge-device id led name summary command as shown in the example below:

  ```
  show cable video session logical-edge-device id 1summary
  Video Session Summary:

  Active        : 1   Init    : 0   Idle      : 0
  Off     : 0   Blocked : 0   PSI-Ready : 1
  UDP     : 1   ASM     : 0   SSM : 0
  Remap   : 1   Data    : 0   Passthru  : 0
  Total Sessions: 1
  ```

- The individual session information can be displayed for the entire LED, for a particular port or line card. The details of a single session may be displayed by specifying a session-id or session-name. To display all the sessions on the LED, use the show cable video session logical-edge-device name led name command as shown in the example below:

```
show cable video session logical-edge-device name pkvodled
Total Sessions = 1

Session Output Streaming Session Destination UDP   Output  Input     Output Input
Id Port  Type      Type               Port  Program State     State  Bitrate
-------------------------------------------------------------------------------
1048576 1      Remap     UDP     174.101.1.1 4915  1 ACTIVE-PSI ON    732788

Output  Encrypt  Encrypt   Session
Bitrate Type     Status    Name
-----------------------------------
1715446 PowerKey Encrypted 0x0000000000001
```

If the session is encrypted and transmitted properly, the session is displayed as shown in the above example. The input state is "ACTIVE-PSI". The output state is "ON". For PowerKEY encrypted sessions, the Encrypt Type will be "PowerKey" and the Encrypt Status will be "Encrypted".

If the session is created as a clear session, then the Encrypt Type will be "CLEAR" and the Encrypt Status will be "-".

Configuration Examples

This section provides configuration examples for the PowerKEY VOD feature:

Example: Configuring Encryption Type on the Line Card

The following example shows how to create a management IP interface:

```
configure terminal cable video encryption
linecard 6/0 ca-system powerkey scrambler des
exit
```

Example: Configuring Encrypted Virtual Carrier Groups

The following example shows how to configure the QAM channels from 64 to 158. These channels are encryption capable once the VCG is successfully bound to a Service Distribution Group. The sessions created on these QAM carriers are encrypted using the scrambler installed on the line card.

```
configure terminal cable video
virtual-carrier-group RPC_VCG
encrypt
rf-channel 20-47 tsid 20-47 output-port-number 20-47
virtual-edge-input-ip 174.102.1.1 input-port-number 1
exit
```

Example: Configuring Service Distribution Groups and Binding

The following example shows how to configure the service distribution groups and binding:

```
configure terminal cable video
  mgmt-intf VirtualPortGroup 0

service-distribution-group sdg1 id 1
    rpd downstream-cable 7/0/0
virtual-carrier-group vcg1 id 1
    service-type narrowcast
    encrypt
    rf-channel 0-10 tsid 1-11 output-port-number 1-11

bind-vcg
    vcg vcg1 sdg sdg1
logical-edge-device led1 id 1
    protocol gqi
      mgmt-ip 1.22.2.10
      mac-address c414.3c17.e001
      server 1.200.1.189
      keepalive retry 3 interval 10
      reset interval 8
      virtual-edge-input-ip 174.102.1.1 input-port-number 1
      vcg vcg2
      active
```

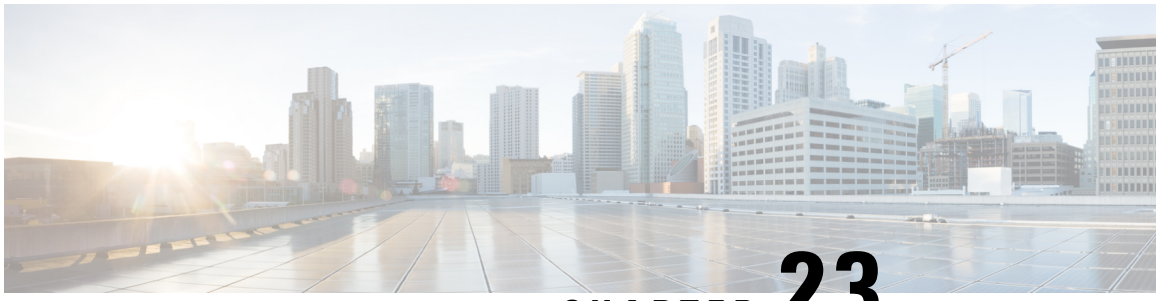
Feature Information for Rmote PHY PowerKEY VoD

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 www.cisco.com/go/cfn 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 47: Feature Information for RPHY PowerKEY VoD

Feature Name	Releases	Feature Information
Remote PHY PowerKEY VoD	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into Cisco Remonte PHY Device.



CHAPTER 23

Cisco Remote PHY Pre-encrypted Broadcast Video

This document describes how to configure pre-encrypted Broadcast Video sessions on Cisco cBR-8 routers.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 48: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information About Pre-encrypted Broadcast Video

The Cisco cBR-8 line card supports broadcast video. It also provides support to the WAN ports for receiving Multi program Transport Streams (MPTS). The Cisco cBR passes the MPTS streams in its entirety to multiple RPDs in the network to provide an output on their RF ports.

The content is multiplexed and encrypted during upstream traffic and reaches Cisco cBR-8 router as pre-encrypted in a constant bit-rate MPTS with all the PSI present. The Cisco cBR routers perform the following:

- De-jittering
- Clock recovery
- PCR re-stamping
- Regenerates PAT with correct TSID

Typically, multi-system operators (MSO) have between 64 and 75 carriers of Broadcast video content in their system. In the RPHY environment, the Cisco cBR routers convert the Broadcast carriers into DEPI multicast streams and send them to an unlimited number of RPDs over the Converged Interconnect Network.

Multicast Table-based Sessions

Similar to table-based unicast session configuration, sessions can be configured as individual sessions under each QAM carrier that is assigned to a table-based LED. To configure multicast video session, you must configure a port-channel interface.

A multicast session can be configured with a single input multicast input source or multiple input sources for backup purpose. For multiple backup sources, a label is required to be associated with the session configuration. Same label can be applied to multiple sessions on different QAM channel. These sessions are considered as cloned sessions.

For session cloning on multiple QAMs within the same line card, only one copy of the traffic is forwarded to the line card. The line card replicates the input packets and forwards them to multiple QAMs. Each cloned copy of a remapped session will have the same or different output program number.

MPTS Pass-through Session

The Cisco cBR-8 router supports multicast MPTS pass-session type. For a pass-through session:

- The PMT and other program data are not changed.
- PID remapping is not performed.
- Input NULL packets are dropped.
- Oversubscription results in random TP dropping, and all ghost PIDs are preserved in the output.

How to Configure Pre-encrypted Broadcast Video Sessions

Note To know more about the commands referenced in this section, see the Cisco IOS Master Command List.

This section contains the following:

Configure a Port-Channel Interface

The following example shows how to configure a port-channel interface.

```
interface Port-channel27
description connection for Core A
ip address 2.27.1.1 255.255.255.252
ip pim sparse-mode
ip access-group 101 out
ip igmp version 3
ip ospf 64512 area 27
load-interval 30
carrier-delay msec 500
```

Configuring Pre-encrypted Broadcast Sessions

The following example shows how to configure the pre-encrypted Broadcast Video sessions on Cisco cBR routers.

```
cable video
multicast-uplink Port-channel32 access-list all-multicasts

table-based
   multicast-label label group group-ip source source-ip source2 source-ip source3 source-ip
 source4 source-ip
   multicast-label label group group-ip source source-ip source2 source-ip source3 source-ip
 source4 source-ip

   vcg vcg-name
  rf-channel channel
    session session-name multicast-label label processing-type {remap | passthru | data}
cbr
  rf-channel channel
    session session-name multicast-label label processing-type {remap | passthru | data}
cbr
```

Configuring the Service Distribution Groups and Binding

The Service Distribution Group (SDG) defines the physical slot/bay/port to be used in a video service. After you configure an SDG, you can bind a VCG to an SDG. The binding connects the carriers defined in the VCG to the physical port listed in the SDG. After binding, a path from the Virtual Edge Input (VEI) is mapped to the RF channels.

The following example shows how to configure the SDGs and binding:

```
configure terminal
cable video
service-distribution-group sdg99 id 99
    rpd downstream-cable 9/0/31

  virtual-carrier-group vcg99 id 99
    service-type broadcast
    rf-channel 64-78 tsid 38901-38915 output-port-number 1-15
    rf-channel 80-127 tsid 38917-38964 output-port-number 17-64

  bind-vcg
    vcg vcg99 sdg sdg99

logical-edge-device led31 id 31
protocol table-based
vcg vcg99
active
```

Configuration Example for Pre-encrypted Broadcast Video Session

The following example shows an example of configuring pre-encrypted Broadcast Video sessions on Cisco cBR routers.

```
cable video
table-based
   multicast-label mpts1 group 236.0.1.1 source 175.10.5.2 source2 175.10.6.2 source3
175.10.7.2 source4 175.10.8.2
   multicast-label mpts2 group 236.0.1.2 source 175.10.5.2 source2 175.10.6.2 source3
175.10.7.2 source4 175.10.8.2
   vcg vcg99
  rf-channel 64
    session mpts1 multicast-label mpts1 processing-type passthru cbr
  rf-channel 65
    session mpts2 multicast-label mpts2 processing-type passthru cbr
```

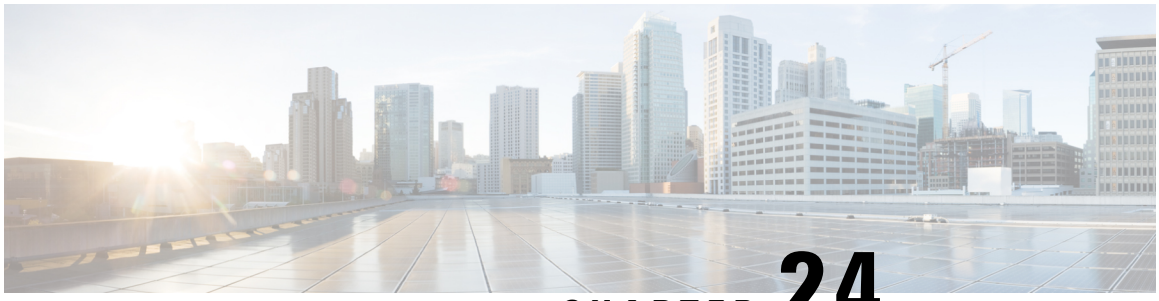
Feature Information for RPHY Pre-encrypted Broadcast Video

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 www.cisco.com/go/cfn 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 49: Feature Information for RPHY Pre-encrypted Broadcast Video

Feature Name	Releases	Feature Information
RPHY Pre-encrypted Broadcast Video	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into Cisco Remote PHY Device.



CHAPTER 24

Remote PHY BFS QAM Configuration

This document provides information on how to configure Cisco cBR-8 as a Broadcast File System (BFS) Quadrature Amplitude Modulation (QAM), which interfaces with Explorer Controller (EC) versions 7.x and 8.x.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 50: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information About BFS QAM Support

The BFS provides a mechanism for a standardized downloading of applications, games, images, and other data formats required by the applications. The BFS QAM enables the router to transfer the broadcast data from an EC to the target platform such as a set-top unit. All forms of BFS data from EC flows as IP multicast, except the CVT carousel, which is through the GQI insert packets.

The BFS QAM configuration on the Cisco cBR-8 router varies based on the version of EC, which interfaces with the router.

- For EC 7.x-Model a GQI-based LED as BFS QAM. One for each LC on Cisco cBR-8.

  For Remote PHY-A single GQI-based LED as BFS QAM for the entire Cisco cBR-8 chassis, as the Cisco cBR-8 can support DEPI multicast for all Remote PHY devices (RPD).

  For EC 8.x-EC 8.x multicasts CVT carousel data in addition to GQI insert packets, but only in the presence of GQAM configured as BFS QAM. Hence, in this setup, a single table-based LED, modeled as BFS QAM, for each Cisco cBR-8 chassis is sufficient. Using cross LC replication, this BFS data can be replicated to other LCs on the Cisco cBR.

How to Configure BFS QAM for EC 7.x

This configuration applies to Cisco cBR-8 routers running Converged Cable Access Platform (CCAP) with Ethernet input and RF output.

If Cisco cBR-8 interacts with EC 7.x, configure an LED on each line card. Use the following procedure to configure BFS QAM on Cisco cBR router.

- Configure an LED with GQI protocol on each line card.
- On EC 7.x, provision BFS QAM.
- Manually create sessions on EC 7.x.
- Generate the QAM, based on GQI model.
- Generate a new source definition and use the new QAM as a target using the same PIDs.
- Ensure that everything is set up on the EC to match the Cisco cBR-8 LED configuration.

Note To know more about the commands referenced in this section, see the Cisco IOS Master Command List.

This section contains the following:

Mapping Cisco cBR-8 as a GQI QAM

On the EC 7.x, configure BFS sessions on the registered BFS QAM by using one of the following:

- Proprietary Remote Procedure Call (RPC) (with GQAM)
- GQI (with RFGW-1)

You can use a standard GQI model where the sessions will be generated on the individual line card on a single LED per line card basis. Individual BFS sessions are added to the LEDs at the Source Definition for all in-band BFS sources. Sessions must be unique in numbering and QAM selection, although all other settings must be duplicates of the original settings.

Creating VCG with One QAM Channel

The following example shows how to create a video virtual carrier group (VCG) with one QAM channel, which can carry the BFS data.

```
enable
configure terminal
cable video

virtual-carrier-group (name) id (id)
    service-type broadcast
    rf-channel (rf-channel number 1) tsid (id) output-port-number (port number 1)
  virtual-carrier-group (name 2) id (id 2)
    service-type broadcast
    rf-channel (rf-channel number 1) tsid (id 2) output-port-number (port number 1)
```

Creating SDG for BFS Sessions on Cisco cBR

The following example shows how to create Service Distribution Group (SDG) for BFS sessions and map this to as many RF ports as required.

```
enable
configure terminal
cable video

service-distribution-group sdg_bdcast id 20
    rf-port integrated-cable 8/0/0
    rf-port integrated-cable 8/0/1
    rf-port integrated-cable 8/0/2
    rf-port integrated-cable 8/0/3
    rf-port integrated-cable 8/0/4
    rf-port integrated-cable 8/0/5
    rf-port integrated-cable 8/0/6
    rf-port integrated-cable 8/0/7
  service-distribution-group sdg_bdcast-9 id 21
    rf-port integrated-cable 9/0/0
    rf-port integrated-cable 9/0/1
    rf-port integrated-cable 9/0/2
    rf-port integrated-cable 9/0/3
    rf-port integrated-cable 9/0/4
    rf-port integrated-cable 9/0/5
    rf-port integrated-cable 9/0/6
    rf-port integrated-cable 9/0/7
```

Create VCG for BFS

The following example shows how to create VCG for BFS.

```
configure terminal
cable video

virtual-carrier-group vcg_bdcast id 20
    service-type broadcast
    rf-channel 76 tsid 1011 output-port-number 1
  virtual-carrier-group vcg_bdcast-9 id 21
    service-type broadcast
    rf-channel 76 tsid 1012 output-port-number 1



vcg vcg_bdcast sdg sdg_bdcast
    vcg vcg_bdcast-9 sdg sdg_bdcast-9

bind-vcg
    vcg vcg_bdcast sdg sdg_bdcast
    vcg vcg_bdcast-9 sdg sdg_bdcast-9
```

Creating Logical Edge Device

The following example shows how to create an LED.

Note Ensure that the LED settings are the same as GQI QAM settings on the EC. For more details, see Creating GQI QAM for BFS on EC 7.x

```
enable
configure terminal
cable video

logical-edge-device led_BFS id 20
    protocol gqi
      mgmt-ip 192.0.2.1
      mac-address <MAC address>
      server 198.51.100.1
      keepalive retry 3 interval 10
      reset interval 8
      virtual-edge-input-ip 203.0.113.1 input-port-number 1
      vcg vcg_bdcast
      active
  logical-edge-device led_BFS-9 id 21
    protocol gqi
      mgmt-ip 192.0.2.1
      mac-address <MAC address>
      server 198.51.100.1
      keepalive retry 3 interval 10
      reset interval 8
      virtual-edge-input-ip 203.0.113.1 input-port-number 1
      vcg vcg_bdcast-9
      active
```

Creating GQI QAM for BFS on EC 7.x

Prerequisites

- To create the GQI QAM on the EC, enable packet insertion in the QAM Model.
- You can duplicate the standard RFGW model to ensure that no interference occurs with the current operations.
- The router must have a GQI QAM per LED.
- The individual QAM must be BFS-capable.

Procedure

Use the following procedure to create GQI QAM for BFS.

1. Choose EC > GQI Based QAM Model List > Edit GQI Based QAM.
2. (Optional) Select the BFS Capable checkbox.
3. Choose RF Carriers from the left pane.
4. Ensure that the Carriers and Ethernet Port values are the same as those on the LEDs.

You can create the sessions for each BFS source by generating a Multicast Through GQI Based QAM session through each BFS source's Source Definition.

How to Configure BFS QAM for RPD

This configuration applies to Cisco cBR-8 routers running CCAP with Ethernet input and Ethernet output.

The configuration procedure for RPD is similar to the configuration on Cisco cBR-8 routers with EC 7.x. However, only one LED is needed for BFS QAM configuration.

You can use the sessions configured on the LED on every RPD by defining an Auxiliary Core on each RPD as needed for BFS distribution.

Creating SDG for BFS Sessions for RPD

The following example shows how to create SDG for BFS sessions on RPDs.

```
service-distribution-group sdg_bdcast id 20
    rpd downstream-cable 2/0/30

virtual-carrier-group vcg_bdcast id 20
    service-type broadcast
    rf-channel 79 tsid 1013 output-port-number 1
```

Creating LED for RPD

The following example shows how to create an LED.

```
logical-edge-device led_BFS id 20
    protocol gqi
      mgmt-ip 192.0.2.1
      mac-address <MAC address>
      server 198.51.100.1
      keepalive retry 3 interval 10
      reset interval 8
      virtual-edge-input-ip 203.0.113.1 input-port-number 1
      vcg vcg_bdcast
```

Defining Cable RPD

The RPD definition must include the RPD defined in the BFS SDG for every RPD to which you want to distribute BFS data: The following example shows how to define RPD.

```
cable rpd RPD07
 identifier xxxx.xxxx.xxxx
  core-interface Te2/1/4
  principal
  rpd-ds 0 downstream-cable 2/0/16 profile 11
  rpd-us 0 upstream-cable 2/0/12 profile 1
 core-interface Te2/1/6
  rpd-ds 0 downstream-cable 2/0/30 profile 10
 r-dti 3
 rpd-event profile 0
!
cable rpd RPD08
 identifier xxxx.xxxx.xxxx
 core-interface Te2/1/4
  principal
```

```
 rpd-ds 0 downstream-cable 2/0/17 profile 11
 rpd-us 0 upstream-cable 2/0/14 profile 1
core-interface Te2/1/6
 rpd-ds 0 downstream-cable 2/0/30 profile 10
r-dti 3
rpd-event profile 0
```

For information on how to create GQI QAM on the EC, see Creating GQI QAM for BFS.

How to Configure BFS QAM for EC 8.x

When Cisco cBR-8 interfaces with EC 8.x, all sessions on the router are configured as multicast and perform a multicast join.

The Cisco cBR routers are not directly mapped on the EC. Hence, this BFS QAM configuration requests and processes the multicast BFS sessions that are setup on the actual BFS QAM. If the Cisco cBR-8 routers have to process these sessions, you must set up table-based multicast sessions, which are similar to the ones available on the BFS QAM.

Configure QAM replication group (QRG), spanning across line cards (LC) to replicate these BFS sessions on every RF port (if each RF port is a service group) of every LC.

To replicate across line cards, you must configure table-based sessions. You can perform cross-line-card-replication only through table-based sessions.

Use the following procedure to configure BFS QAM on Cisco cBR router for EC 8.x.

1. Create a VCG with one QAM channel for carrying this BFS data.
2. Within the same VCG, allocate a few more QAM channels for MPTS pass-through sessions.
3. Create VCG for VoD QAM channels.
4. Create VCG for SDV QAM channels.

Creating VCG for VoD QAM Channels

The following example shows how to create VCG for VoD QAM channels.

```
enable
configure terminal
cable video

virtual-carrier-group vcg_VoD
service-type narrowcast
rf-channel 1-32 tsid 2-33 output-port 2-33
```

Creating VCG for SDV QAM Channels

The following example shows how to create VCG for SDV QAM channels.

```
enable
configure terminal
cable video
```

```
virtual-carrier-group vcg_SDV
service-type narrowcast
rf-channel 33-48 tsid 34-49 output-port 34-49
```

Creating SDG

The following procedures are applicable when you create an SDG.

1. Create SDG for broadcast sessions and map this to as many RF ports as required, depending on the Service Groups which need this broadcast data.
2. Create separate SDG for VoD.
3. Create separate SDG for SDV, which probably contains replication.

```
enable
configure terminal
cable video

service-distribution-group sdg_bdcast
  rf-port integrated-cable 1/0/0
  rf-port integrated-cable 1/0/1
  rf-port integrated-cable 2/0/0
  rf-port integrated-cable 2/0/1
  rf-port integrated-cable 3/0/0
  rf-port integrated-cable 3/0/1

service-distribution-group sdg_VoD
  rf-port integrated-cable 1/0/0

service-distribution-group sdg_SDV
  rf-port integrated-cable 1/0/0
  rf-port integrated-cable 1/0/1

bind-vcg
  vcg vcg_BFS sdg sdg_BFS
  vcg vcg_VoD1 sdg sdg_VoD
  vcg vcg_SDV sdg sdg_SDV
```

Creating LEDs

The following procedures are applicable for creating LEDs.

1. Create a table based LED for broadcast carrying BFS and MPTS pass-through sessions.
2. Create separate LEDs for VoD and SDV.

```
logical-edge-device led_BFS id 1
    protocol table-based
      virtual-edge-input-ip 203.0.113.1 input-port-number 1
      vcg vcg_bdcast
      active
  table-based
    vcg vcg_bdcast
      rf-channel 0
        session BFS group 203.0.113.4 start-udp-port 49152 num-sessions-per-qam 1
```

```
processing-type remap start-program 20 bit-rate 300000 jitter 100 vbr
      rf-channel 48 session MPTS_passthru group 203.0.113.5 start-udp-port 49152
num-sessions-per-qam 1 processing-type passthru jitter 100 vbr
      rf-channel 49 session MPTS_passthru group 203.0.113.6 start-udp-port 49152
num-sessions-per-qam 1 processing-type passthru jitter 100 vbr

logical-edge-device led_VoD id 2
    protocol gqi
      virtual-edge-input-ip 203.0.113.1 input-port-number 1
      vcg vcg_VoD
      active
```

Configuration Example for BFS QAM Configuration

This section provides examples for BFS QAM support.

Example: BFS QAM Configuration on Cisco cBR for EC 7.x

The following example shows the BFS QAM configuration for EC 7.x.

```
virtual-carrier-group vcg_bdcast id 20
    service-type broadcast
    rf-channel 76 tsid 1011 output-port-number 1
  virtual-carrier-group vcg_bdcast-9 id 21
    service-type broadcast
    rf-channel 76 tsid 1012 output-port-number 1

service-distribution-group sdg_bdcast id 20
    rf-port integrated-cable 8/0/0
    rf-port integrated-cable 8/0/1
    rf-port integrated-cable 8/0/2
    rf-port integrated-cable 8/0/3
    rf-port integrated-cable 8/0/4
    rf-port integrated-cable 8/0/5
    rf-port integrated-cable 8/0/6
    rf-port integrated-cable 8/0/7
  service-distribution-group sdg_bdcast-9 id 21
    rf-port integrated-cable 9/0/0
    rf-port integrated-cable 9/0/1
    rf-port integrated-cable 9/0/2
    rf-port integrated-cable 9/0/3
    rf-port integrated-cable 9/0/4
    rf-port integrated-cable 9/0/5
    rf-port integrated-cable 9/0/6
    rf-port integrated-cable 9/0/7

virtual-carrier-group vcg_bdcast id 20
    service-type broadcast
    rf-channel 76 tsid 1011 output-port-number 1
  virtual-carrier-group vcg_bdcast-9 id 21
    service-type broadcast
    rf-channel 76 tsid 1012 output-port-number 1

vcg vcg_bdcast sdg sdg_bdcast
    vcg vcg_bdcast-9 sdg sdg_bdcast-9

bind-vcg
    vcg vcg_bdcast sdg sdg_bdcast
```

```
    vcg vcg_bdcast-9 sdg sdg_bdcast-9

logical-edge-device led_BFS id 20
    protocol gqi
      mgmt-ip 192.0.2.1
      mac-address <MAC address>
      server 198.51.100.1
      keepalive retry 3 interval 10
      reset interval 8
      virtual-edge-input-ip 203.0.113.1 input-port-number 1
      vcg vcg_bdcast
      active
  logical-edge-device led_BFS-9 id 21
    protocol gqi
      mgmt-ip 192.0.2.1
      mac-address <MAC address>
      server 198.51.100.1
      keepalive retry 3 interval 10
      reset interval 8
      virtual-edge-input-ip 203.0.113.1 input-port-number 1
      vcg vcg_bdcast-9
      active
```

Example: BFS QAM Configuration on RPD

The following example shows the BFS QAM configuration on RPD.

```
service-distribution-group sdg_bdcast id 20
    rpd downstream-cable 2/0/30

virtual-carrier-group vcg_bdcast id 20
    service-type broadcast
    rf-channel 79 tsid 1013 output-port-number 1

logical-edge-device led_BFS id 20
    protocol gqi
      mgmt-ip 192.0.2.1
      mac-address <MAC address>
      server 198.51.100.1
      keepalive retry 3 interval 10
      reset interval 8
      virtual-edge-input-ip 203.0.113.1 input-port-number 1
      vcg vcg_bdcast
cable rpd RPD07
 identifier xxxx.xxxx.xxxx
 core-interface Te2/1/4
  principal
  rpd-ds 0 downstream-cable 2/0/16 profile 11
  rpd-us 0 upstream-cable 2/0/12 profile 1
 core-interface Te2/1/6
  rpd-ds 0 downstream-cable 2/0/30 profile 10
 r-dti 3
 rpd-event profile 0
!
cable rpd RPD08
 identifier xxxx.xxxx.xxxx
 core-interface Te2/1/4
  principal
  rpd-ds 0 downstream-cable 2/0/17 profile 11
  rpd-us 0 upstream-cable 2/0/14 profile 1
 core-interface Te2/1/6
  rpd-ds 0 downstream-cable 2/0/30 profile 10
```

```
 r-dti 3
 rpd-event profile 0
```

Example: BFS QAM Configuration on Cisco cBR for EC 8.x

The following example shows the BFS QAM configuration for EC 8.x.

```
virtual-carrier-group vcg_bdcast
service-type broadcast
rf-channel 0 tsid 1 out 1
rf-channel 49-63 tsid 50-64 output-port 50-64

virtual-carrier-group vcg_VoD
service-type narrowcast
rf-channel 1-32 tsid 2-33 output-port 2-33

virtual-carrier-group vcg_SDV
service-type narrowcast
rf-channel 33-48 tsid 34-49 output-port 34-49


service-distribution-group sdg_bdcast
rf-port integrated-cable 1/0/0
rf-port integrated-cable 1/0/1
rf-port integrated-cable 2/0/0
rf-port integrated-cable 2/0/1
rf-port integrated-cable 3/0/0
rf-port integrated-cable 3/0/1

service-distribution-group sdg_VoD
rf-port integrated-cable 1/0/0

service-distribution-group sdg_SDV
rf-port integrated-cable 1/0/0
rf-port integrated-cable 1/0/1

bind-vcg
vcg vcg_BFS sdg sdg_BFS
vcg vcg_VoD1 sdg sdg_VoD
vcg vcg_SDV sdg sdg_SDV

logical-edge-device led_BFS id 1
    protocol table-based
      virtual-edge-input-ip 203.0.113.1 input-port-number 1
      vcg vcg_bdcast
      active
  table-based
    vcg vcg_bdcast
      rf-channel 0
        session BFS group 203.0.113.4 start-udp-port 49152 num-sessions-per-qam 1
processing-type remap start-program 20 bit-rate 300000 jitter 100 vbr
      rf-channel 48
        session MPTS_passthru group 203.0.113.5 start-udp-port 49152 num-sessions-per-qam
1 processing-type passthru jitter 100 vbr
       rf-channel 49
        session MPTS_passthru group 203.0.113.6 start-udp-port 49152 num-sessions-per-qam
1 processing-type passthru jitter 100 vbr

logical-edge-device led_VoD id 2
    protocol gqi
      virtual-edge-input-ip 203.0.113.1 input-port-number 1
```

```
vcg vcg_VoD
active
```

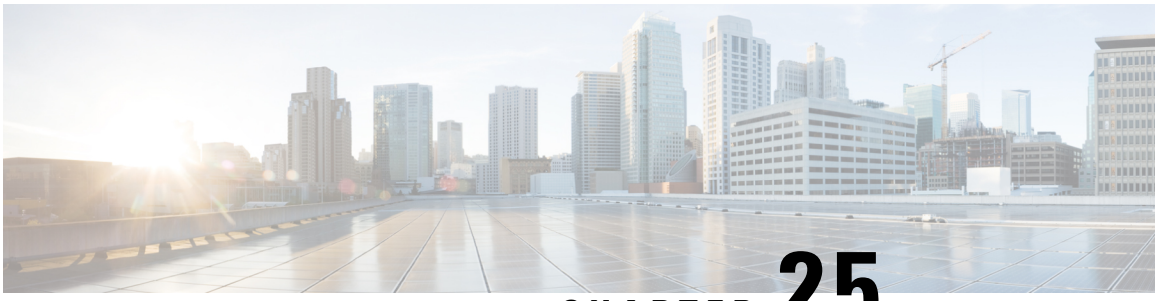
Feature Information for BFS QAM Configuration

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 www.cisco.com/go/cfn 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 51: Feature Information for BFS QAM Configuration

Feature Name	Releases	Feature Information
BFS QAM Configuration	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into Cisco Remote PHY Device.



CHAPTER 25

Remote PHY Switched Digital Video

This document provides information on how to configure Switched Digital Video for Cisco Remote PHY Device.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Switched Digital Video Services

The Switched Digital Video (SDV) services are supported for the MPEG video subsystem on the Cisco Remote PHY Device. It consists of Multicast IP Packet based video streams that are managed as "Video Sessions".The Cisco Remote PHY Device supports both Any Source Multicast (ASM) and Source Specific Multicast (SSM) sessions.

- For ASM, the input is identified by the group IP address.
- For SSM, the input is identified by the source and group IP address pair.

In both cases, the UDP ports are ignored. Both ASM and SSM can co-exist but cannot overlap in a group IP address. Hence, for a group IP address, either a single ASM, or one or more SSM can be used.

Session Cloning

Session cloning refers to the ability of forwarding an input to multiple output QAM channels. Only multicast sessions can be cloned. The output QAM channels are located on the same or different line cards. However, an input cannot be cloned on the same QAM channel. Cloning is available on session-based GQIv2 or Table-based sessions. It is applicable to re-mapped, pass-through, and data piping sessions. All cloned sessions must have the same processing type, bitrate and jitter value. For re-mapped sessions, each output copy will have a different output program number.

Redundant Multicast Sources

The redundant multicast sources feature supports up to four SSM/ASM multicast address pairs per video session. However, only multicast traffic from one source is forwarded to the output QAMs. When the active source fails, another source is chosen automatically. Multicast sources must be unique within a redundant group and cannot overlap across redundant groups.

The order of the sources is critical when multicast sessions are configured via GQI or VSRM. For a given group IP address, the source IP addresses must be specified in the same order.

For example: The group IP address 232.1.2.3 used with two sessions must have the source IP addresses specified in the same order.

Session A configured with group IP 232.1.2.3 source 174.2.3.4 source2 174.4.5.6 source3 174.7.8.9 and session B or any session created after session A configured using group IP 232.1.2.3, must have the source IP addresses in this same order as specified for session A. That is, source 174.2.3.4 source2 174.4.5.6 source3 174.7.8.9.

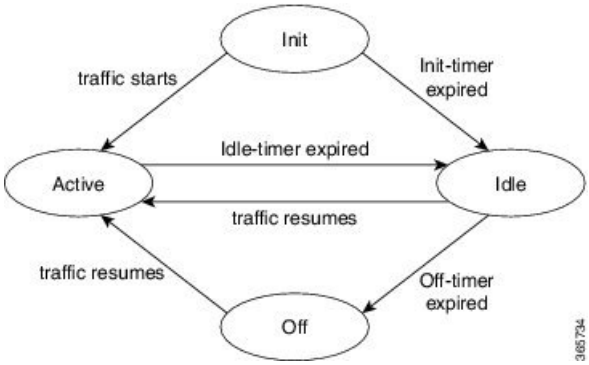
This ensures that all sessions switch to the same source IP address when a source switch occurs. Additionally, sessions configured via GQI have up to three sources available for redundancy, whereas multicast labels configured for table-based sessions have up to four sources available for redundancy.

Multicast labels must use unique groups and S/G pairs. These pairs cannot be used by other multicast labels or by multicast sessions that use S/G pairs. For example, when one multicast session uses {[S1, G], [S2, G] and [S3, G]}, another session cannot use {[S1, G], [S4, G]}.

Multicast source change is based on the session state; INIT, IDLE, ACTIVE or OFF. A session configured for the first time is in INIT state and stays in this state for a brief time. If traffic starts before the INIT timer expires, it moves to the ACTIVE state, otherwise to the IDLE state.

When traffic starts, the session remains in ACTIVE state as long as traffic continues to flow. When traffic stops for a time longer than the IDLE timer, the session moves to IDLE state. During IDLE state, PAT and PMT of the session is retained as the output. If traffic resumes in this state, the session moves to ACTIVE state again with all its previous PSI and remapping information unaltered.

In IDLE state, if traffic does not start or resume before the OFF timer expires, the session transitions to OFF state. When traffic resumes for a session in OFF state, it is treated as a new session.



Sessions that transition from ACTIVE to IDLE have higher priority and will be moved to the backup source than those that were newly created and have changed from INIT to IDLE.

Benefits of Switched Digital Video

Switched Digital Video provides the following benefits:

- Saves space, maintenance and cost.
- Allows customers to oversubscribe bandwidth.

Prerequisites for Switched Digital Video

- To access multicast capability, configure multicast routing.
- To switch sources for table-based sessions, configure at least two sources for a multicast label and then associate with the desired session.

Restrictions for Switched Digital Video

- While creating a multicast label, up to four sources can be associated with one group IP address.
- Labels are used with table-based video sessions only.
- Sessions created with GQI Tools do not use labels. However, they can have up to three sources associated with one group IP address.

Information About Switched Digital Video

QAM Sharing

Unicast and multicast video sessions can co-exist on the same QAM channel for VOD, SDV or Gaming sessions. QAM sharing requires a common Edge Resource Manager to avoid oversubscription of QAM resources between services.

Note QAM sharing with MPTS pass-thru sessions is not supported.

QAM Replication

Multicast sessions can be replicated from one port to other ports on the same line card and/or across line cards.

The difference between a cloned session and replicated sessions is:

- Cloned sessions are initiated by a user on session creation. Each session has a unique session id and may have different output configuration.
- Replicated sessions have the same output configuration attributes. For sessions that are replicated across line cards, session on each line card will have its own unique session id.

MPTS Pass-through Session

Switched digital video (SDV) sessions are typically multicast SPTS remap type. The Cisco Remote PHY Device also supports multicast MPTS pass-through and data-piping session types.

The MPTS session is assumed to have no collision in the PID space and program number space with other sessions that already exist within a QAM. Hence, SPTS remap and MPTS pass-through sessions cannot co-exist on the same QAM. Otherwise, there might be conflict when the PID and program numbers in the MPTS and SPTS remuxing are not unique on the output QAM channel.

For a pass-through session:

- The PAT is snooped and regenerated with the correct TSID.
- The PMT and other program data are not changed.
- PID remapping is not performed.
- Input NULL packets are dropped.
- Oversubscription results in random TP dropping, and all ghost PIDs are preserved in the output.

How to Configure the Switched Digital Video Services

Configuring Multicast Routing

You can enable IP Multicast Distributed Switching (MDS) to provide distributed switching of multicast packets received at the line cards.

```
enable
configure terminal
 ip multicast-routing distributed
 ip pim ssm range all-multicasts
 ip pim rp-address ip-address
```

```
interface type number
 ip pim sparse-dense-mode
 ip igmp version 3
cable video
 multicast-uplink interface-name access-list access-list-name
```

Configuring Multicast Label

The Cisco Remote PHY Device supports up to four multicast address pairs per multicast session for backup purpose. To specify additional sources for a multicast session for table-based, a label needs to be configured and attached to the session configuration. A maximum of 2000 multicast labels can be created but only 2048 multicast addresses can be active at a time.

Multicast label is used for table-based session configuration when more than one multicast source [S, G] is used as backup for the sessions. A mullticast label can only be created or deleted; it cannot be modified. The multicast label cannot be deleted before the sessions using it are removed.

Groups used by multicast labels must be unique like the multicast S/G pairs. However, sources may be used by more than one label as long as the group is unique. A maximum of 4 multicast sources is allowed in one label. If the label is used in multiple sessions, the sessions are considered as cloned sessions.

```
enable
configure terminal
 cable video
  table-based
   multicast-label label group group-ip source source-ip source2 source-ip source3
source-ip source4 source-ip
```

Configuring Multicast Table-based Sessions

Similar to table-based unicast session configuration, sessions can be configured as individual sessions under each QAM carrier that is assigned to a table-based LED.

A multicast session can be configured with a single input multicast input source or multiple input sources for backup purpose. For multiple backup sources, a label is required to be associated with the session configuration. Same label can be applied to multiple sessions on different QAM channel. These sessions are considered as cloned sessions.

For session cloning on multiple QAMs within the same line card, only one copy of the traffic is forwarded to the line card. The line card replicates the input packets and forwards them to multiple QAMs. Each cloned copy of a remapped session will have the same or different output program number.

```
enable
configure terminal
 cable video
  table-based
   vcg vcg-name
    rf-channel channel
     session session-name group group-ip source source-ip processing-type {remap
```

```
| passthru | data} start-program program-num [bit-rate bit-rate-number] [jitter
jitter-number] [cbr | vbr]
```

Configuring Source Switching

Source switching happens automatically when the current source goes down. If more than one source IP is configured, the software will automatically switch to the next valid source IP, if it is available. However, to force switch from one valid source to another valid source, use the following commands:

```
Router(config)# cable video source-switch from-group group-ip from-source
source-ip

or

Router(config)# cable video source-switch to-group group-ip to-source source-ip
```

Verifying Switched Digital Video Configuration

```
Router#show cable video session logical-edge-device id 2
Total Sessions = 4

Session    Output     Streaming   Session Session Source                  UDP   Output
Input      Output Input    Output   Encrypt  Encrypt        Session
Id         Port       Type         Type    Ucast Dest IP/Mcast IP (S,G)    Port  Program
State      State  Bitrate  Bitrate  Type     Status         Name
-------------------------------------------------------------------------------------
2097152    142        Remap       SSM     175.2.5.6,232.5.6.7             0     1       OFF
        ON     0        0        CLEAR    -              SESS_PME2.1.7.338
2097153    163        Remap       SSM     175.6.1.13,232.2.1.6             0     2
INIT       ON     0        0        CLEAR    -              SESS_PME3.1.7.497
2097154    184        Passthru    SSM     175.2.6.7,232.5.6.15            0     -       OFF
        ON     0        0        CLEAR    -              SESS_PME4.1.7.656
2097155    230        Data-Piping SSM     175.7.2.2,232.2.6.7             0     -       OFF
        ON     0        0        CLEAR    -              SESS_PME6.1.7.978

Router#show cable video session logical-edge-device id 2 session-id 2097152
Session Name        : SESS_PME2.1.7.338
Session Id:         : 2097152
Creation Time:      : Fri Jun 24 16:30:45 2016

Output Port         : 142
TSID                : 142
ONID                : 0
Number of Sources   : 1
  Source IP         : 175.2.5.6
  Group IP          : 232.5.6.7
  UDP Port          : 0
Config Bitrate      : not specified
Jitter              : 100 ms
Processing Type     : Remap
Stream Rate         : VBR
Program Number      : 1
Idle Timeout        : 2000 msec
Init Timeout        : 2000 msec
Off Timeout         : 60 sec
Encryption Type     : CLEAR
```

```
Encryption Status   : -

Input Session Stats:
====================
  State: OFF, Uptime: 0 days 00:26:35
  IP Packets: In 0, RTP 0, Drop 0
  TP Packets: In 0, PCR 0, PSI 0, Null 0
              Unreference 0, Discontinuity 0
  Errors: Sync loss 0, CC error 0, PCR Jump 0,
          Underflow 0, Overflow 0, Block 0
  Bitrate: Measured 0 bps, PCR 0 bps

Output Session Stats:
=====================
  State: ON, Uptime: 0 days 00:26:35
  TP Packets: In 0, PCR 0, PSI 0,
              Drop 0, Forward 0, Insert 0
  Errors: Info Overrun 0, Info Error 0, Block 0, Overdue 0,
          Invalid Rate 0, Underflow 0, Overflow 0
  Bitrate: Measured 0 bps
```

Troubleshooting Switched Digital Video Configuration

Problem	Possible Causes	Recommended Solution
%ERROR: Duplicate multicast source 175.2.5.6 group 232.5.6.7 not allowed for use in label groupDuplicate.	Group and Source are already used in an existing label.	Assign unique group and source IPs across multicast labels.
%ERROR: Duplicate multicast source 178.3.3.3 group 232.222.222.222 not allowed within label DuplicateSourceHere.	Source has been repeated within a label.	Assign unique source IP within a multicast label.
%ERROR: Duplicate multicast source 175.2.5.6 group 232.5.6.7 not allowed for use in this session.	Session has been created with a duplicate group IP. This group IP has been used in an existing multicast label.	Create the session with a unique group IP.
%ERROR Only one multicast session can be created per multicast session command; rf-channel range values, such as rf-channel 20-30, not allowed.	Session has been created on a range of RF channels.	RF channel range is not allowed. Create the session on an RF channel.

Configuration Examples for Switched Digital Video

Example 1: Table-based Multicast Session Configuration

```
enable
```

```
configure terminal
ip pim rp-address 9.1.1.1
ip pim ssm range all-multicasts
ip access-list standard all-multicasts
 permit 233.0.0.0 0.255.255.255
 permit 234.0.0.0 0.255.255.255
 permit 235.0.0.0 0.255.255.255
 permit 236.0.0.0 0.255.255.255
 permit 237.0.0.0 0.255.255.255
 permit 238.0.0.0 0.255.255.255
 permit 232.0.0.0 0.255.255.255
 permit 224.0.0.0 0.255.255.255
 permit 239.0.0.0 0.255.255.255
interface TenGigabitEthernet4/1/2
 ip address 2.33.1.1 255.255.255.252
 ip pim sparse-mode
 ip igmp version 3
 ip ospf 64512 area 9
 load-interval 30
cable video
  multicast-uplink TenGigabitEthernet4/1/2 access-list all-multicasts
  service-distribution-group sdg-1 id 1
    rf-port downstream-cable 7/0/0
  virtual-carrier-group vcg-1 id 1
    service-type narrowcast
    rf-channel 0-55 tsid 1-56 output-port-number 1-56
  bind-vcg
    vcg vcg-1 sdg sdg-1
  logical-edge-device led_multicast id 1
    protocol table-based
      virtual-edge-input-ip 174.102.1.1 input-port-number 1
      vcg vcg-1
      active
  table-based
   multicast-label label1 group 232.2.1.1 source 175.2.2.2
    vcg vcg-1
      rf-channel 0
        session mcast1 multicast-label label1 processing-type remap start-program 1 jitter
 100 vbr
        session mcast2 group 236.0.1.1 source 175.10.5.2 processing-type passthru jitter
100 cbr
```

Example 2: Table-based Configuration for Replicated Multicast Pass-through Sessions

Below is a table-based configuration for multicast pass-through sessions replicated to all QAM ports on the same line card.

```
enable
configure terminal
cable video
  multicast-uplink TenGigabitEthernet4/1/2 access-list all-multicasts
  service-distribution-group sdg1 id 1
    rf-port downstream-cable 7/0/0
    rf-port downstream-cable 7/0/1
    rf-port downstream-cable 7/0/2
    rf-port downstream-cable 7/0/3
    rf-port downstream-cable 7/0/4
    rf-port downstream-cable 7/0/5
    rf-port downstream-cable 7/0/6
    rf-port downstream-cable 7/0/7
  virtual-carrier-group vcg1 id 1
```

```
    rf-channel 0-95 tsid 0-95 output-port-number 1-96
  bind-vcg
    vcg vcg1 sdg sdg1
  logical-edge-device led1 id 1
    protocol table-based
      virtual-edge-input-ip 174.102.1.1 input-port-number 1
      vcg vcg1
      active
  table-based
    multicast-label mlabel1 group 236.0.1.1 source 175.10.5.2 source2 175.10.6.20 source3
175.10.7.2
    vcg vcg1
     rf-channel 0
      session mcast1 multicast-label mlabel1 processing-type passthru vbr
     rf-channel 5
      session mcast2 group 237.0.1.1 source 175.10.6.2 processing-type passthru vbr
```

Example 3: QAM Sharing Configuration

Below is an example of how to create a PMT encrypted table-based session for both VOD and SDV on the same QAM channel on 7/0/0 RF port.

```
cable video
  multicast-uplink TenGigabitEthernet4/1/2 access-list all-multicasts
  mgmt-intf VirtualPortGroup 0
  encryption
    linecard 7/0 ca-system pme scrambler dvs042
    pme vodsid 111
    pme cem 1.200.1.163 5000
    pme mgmt-ip 1.33.2.6
  service-distribution-group sdg1 id 1
    rf-port downstream-cable 7/0/0
  virtual-carrier-group vcg1 id 1
    virtual-edge-input-ip 174.102.1.1 input-port-number 1
    encrypt
    service-type narrowcast
    rf-channel 20-34 tsid 20-34 output-port-number 20-34
  bind-vcg
    vcg vcg1 sdg sdg1
  logical-edge-device led1 id 1
    protocol table-based
      vcg vcg1
      active
  table-based
    multicast-label mlabel1 group 236.0.1.1 source 175.10.5.2 source2 175.10.6.2 source3
175.10.7.2
    vcg vcg1
      rf-channel 20
        session VOD input-port 1 start-udp-port 49152 processing-type remap start-program
1 jitter 100 vbr
       session SDV multicast-label mlabel1 processing-type remap start-program 1000 jitter
 100 vbr
!
```

Example 4: QAM Replication Configuration

Below is an example of how to configure multicast sessions with four backup sources and replicated on multiple line cards and multiple RF ports within the same line card.

```
cable video
  multicast-uplink TenGigabitEthernet4/1/2 access-list all-multicasts
  service-distribution-group sdg-1 id 1
    rf-port downstream-cable 7/0/0
    rf-port downstream-cable 7/0/1
    rf-port downstream-cable 8/0/0
    rf-port downstream-cable 8/0/1
  virtual-carrier-group vcg-1 id 1
    service-type broadcast
    rf-channel 0-55 tsid 1-56 output-port-number 1-56
bind-vcg
    vcg vcg-1 sdg sdg-1
  logical-edge-device led_multicast id 1
    protocol table-based
      virtual-edge-input-ip 174.102.1.1 input-port-number 1
      vcg vcg-1
    active
  table-based
    multicast-label label1 group 232.2.1.1 source 175.2.2.2 source2 175.2.3.2 source3
175.2.4.2 source4 175.5.1.12
    vcg vcg-1
      rf-channel 0
        session mcast1 multicast-label label1 processing-type remap start-program 1 jitter
 100 vbr
```

Example 5: SSM Session Configuration

The following examples show how to configure SSM sessions on a range of QAM channels with three multicast sources.

```
table-based
    multicast-label label110_1 group 232.2.1.35 source 175.2.2.2 source2 175.6.1.12 source3
 175.2.9.2
    multicast-label label103_1 group 232.2.1.30 source 175.2.2.2 source2 175.6.1.12 source3
 175.2.9.2
    vcg vcg-uni-multi0
      rf-channel 0
        session mcast multicast-label label110_1 processing-type remap start-program 1
jitter 100 cbr
      rf-channel 6
        session mcast multicast-label label103_1 processing-type remap start-program 1
jitter 100 cbr
```

Example 6: Multicast Session with Virtual Carrier Group as Service Type Broadcast Configuration

```
  virtual-carrier-group VCG_PME0 id 1
    service-type broadcast
    rf-channel 20-35 tsid 100-115 output-port-number 100-115

  table-based
    multicast-label a2 group 232.5.6.7 source 175.2.5.6
   multicast-label exampleLabel group 232.2.1.6 source 175.6.1.13 source2 175.6.1.12 source3
 180.1.1.1 source4 175.6.1.14
    vcg VCG_PME2
      rf-channel 22
        session SESS_PME2 multicast-label a2 processing-type remap start-program 1
    vcg VCG_PME3
      rf-channel 23
```

```
      session SESS_PME3 multicast-label exampleLabel processing-type remap start-program
2
```

Example 7: Sessions with Passthru and Data Processing Type

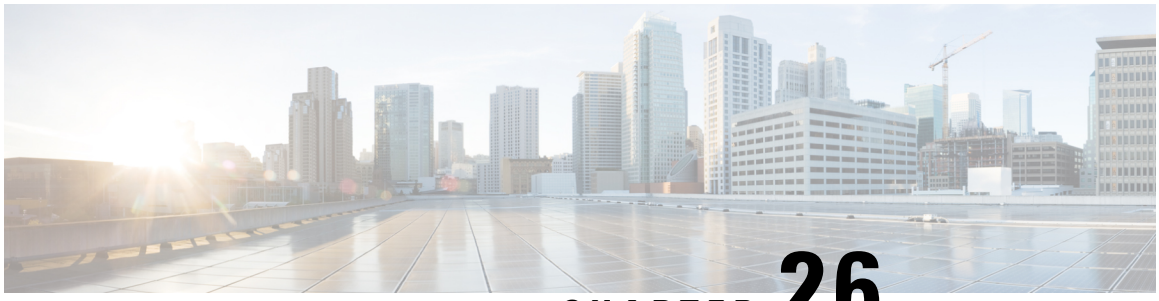
```
   table-based
   multicast-label a2 group 232.5.6.7 source 175.2.5.6
  multicast-label exampleLabel group 232.2.1.6 source 175.6.1.13 source2 175.6.1.12 source3
180.1.1.1 source4 175.6.1.14
   vcg VCG_PME2
     rf-channel 22
       session SESS_PME2 multicast-label a2 processing-type remap start-program 1
   vcg VCG_PME3
     rf-channel 23
       session SESS_PME3 multicast-label exampleLabel processing-type remap start-program
2
   vcg VCG_PME4
     rf-channel 24
       session SESS_PME4 group 232.5.6.15 source 175.2.6.7 processing-type passthru
   vcg VCG_PME6
     rf-channel 30
       session SESS_PME6 group 232.2.6.7 source 175.7.2.2 processing-type data
```

Feature Information for Switched Digital Video

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 www.cisco.com/go/cfn 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.

Feature Name	Releases	Feature Information
Switched Digital Video	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.



CHAPTER 26

Remote PHY QAM Profile Configuration

This document describes how to configure the QAM profile on the Cisco cBR Series Converged Broadband Router.

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Information About QAM Profile

A QAM profile describes the common downstream channel modulator settings, referred to as physical layer parameters. This includes QAM constellation, symbol rate, interleaver-depth, spectrum-inversion, and annex.

The QAM profile is described by CCAP DownPhyParams object. Default QAM profiles are supported and customized for DOCSIS or MPEG Video, which are described as DocsisPhyDefault and VideoPhyDefault objects, respectively.

A maximum of 32 QAM profiles can be defined. There are four system-defined QAM profiles (0 to 3), which cannot be deleted or modified. You can define profiles 4 to 31.

The system defined profiles are:

- Profile 0 - default-annex-b-64-qam
  - interleaver-depth: I32-J4
  - symbol rate: 5057 kilo-symbol/second
  - spectrum-inversion: off

- Profile 1 - default-annex-b-256-qam
  - interleaver-depth: I32-J4
  - symbol rate: 5361 kilo-symbol/second
  - spectrum-inversion: off
- Profile 2 - default-annex-a-64-qam
  - interleaver-depth: I12-J17
  - symbol rate: 6952 kilo-symbol/second
  - spectrum-inversion: off

Profile 3 - default-annex-a-256-qam

- interleaver-depth: I12-J17
- symbol rate: 6952 kilo-symbol/second
- spectrum-inversion: off

How to Configure Remote PHY QAM Profile

Note To know more about the commands referenced in this section, see the Cisco IOS Master Command List.

Configuring the QAM Profile on Downstream Channels

```
Enable
configure terminal
  cabledownstream qam-profile Qam_Profile_ID D

   annex {A | B | C}
   description LINE
   interleaver-depth {I12-J17 | I128-J1 | I128-J2 |
I128-J3 | I128-J4 | I128-J5 | I128-J6 | I128-J7 |
I128-J8 | I16-J8 | I32-J4 | I64-J2 | I8-J16}
  modulation {256 | 64}   spectrum-inversion {off | on}
  symbol-rate value
exit
```

You can configure symbol rate for Annex A video and Annex C video. The valid range for Annex A video is 3500 to 7000 kilo-symbols/sec. The valid range for Annex C video is 3500 to 5309 kilo-symbols/sec. The channel width in kHz is symbol-rate * (1 + alpha) with 0.15 alpha for Annex A and 0.13 alpha for Annex C.

Verifying QAM Profile on Downstream Channels

Use the following commands to verify the QAM Profile on Downstream Channels:

```
Router#show running-config | section downstream controller-profile
cable downstream controller-profile 0
 rf-chan 0 3
  type DOCSIS
  frequency 111000000
  rf-output NORMAL
  qam-profile 1
  docsis-channel-id 1
```

Configuration Example

QAM Profile Configuration

```
configure terminal
  cable downstream controller-profile 1
    multicast-pool 20
    Rf-channel 0 15
     Type docsis
     Frequency 111000000
     Rf-output NORMAL
     Qam-profile 1
     Docsis-channel-id 1
  cable downstream controller-profile 2
    multicast-pool 20
    Rf-channel 20 47
     Type video sync
     Frequency 231000000
     Rf-output NORMAL
     Qam-profile 14
```

Feature Information for QAM Profile Configuration

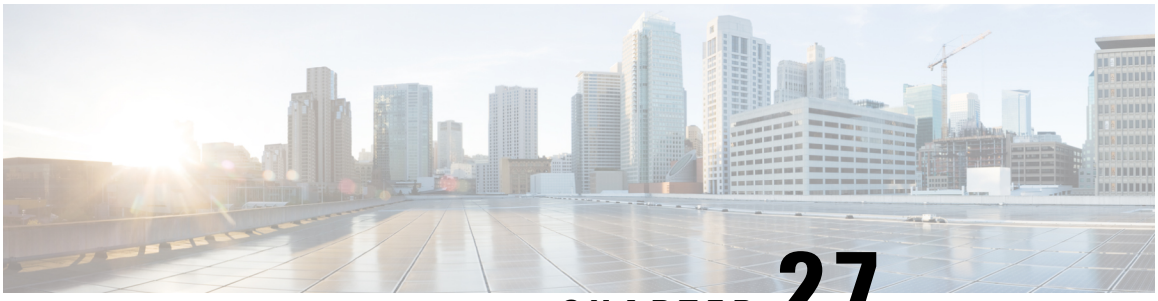
Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the www.cisco.com/go/cfn 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 52: Feature Information for QAM Profile Configuration

Feature Name	Releases	Feature Information
QAM Profile Configuration-RPHY Annex B	Cisco 1x2 / Compact Shelf RPD Software 1.1	This feature was introduced on the Cisco Remote PHY Device.

Feature Name	Releases	Feature Information
QAM Profile Configuration-RPHY Annex A and C	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was introduced on the Cisco Remote PHY Device.



CHAPTER 27

Cisco Remote PHY Out of Band

Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link http://tools.cisco.com/ITDIT/CFN/. An account at the http://www.cisco.com/ site is not required.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 53: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information About Out of Band

Out of Band (OOB) data is used by set-top boxes on the cable plant for the delivery of data streams that support set-top box operation in the downstream and to convey responses and commands from the STB in the upstream.

The two OOB systems are OOB 55-1 and OOB 55-2. The OOB 55-2 system has a scheduled TDMA upstream, which is intolerant of packet network latency. The SCTE 55-1 system does not include such upstream scheduling capabilities, however requires multiple upstream frequencies to operate.

OOB 55-1

To facilitate the delivery of OOB streams from the headend to the customer-facing CPE via the Remote PHY (R-PHY) architecture, a solution is needed that delivers the OOB streams to the RPD via the same Ethernet carriers that the rest of the services traverse. The following sections describe 55-1 OOB approaches to this transport:

For downstream:

- Ethernet from the OM device: The OM processes OOB source streams per SCTE-55-1 and outputs datagrams via IP multicast.

- CCAP-Core forward as virtrual OM: The CCAP joins and processes streams from OM device per SCTE-55-1 and forwards them downstream to the RPD.

For upstream:

- ATM from STB: The STB send augment ATM upstream packet to RPD per SCTE-55-1, RPD build up upstream packet per ARPD protocol (version 2) and forward it to CCAP core.
- CCAP-Core forward as virtrual ARPD: The CCAP receive 55-1 packet via UEPI and forwards them upstream to the NC.

The Out-of-Band Modulator (OM) handles the receiving of OOB source data streams and creating a multiplexed signal in accordance with OOB 55-1. The MPEG transport stream, containing the OOB is IP multicast using the UDP to the CCAP Core over an Ethernet link.

Each OM can output only a single OOB multiplex. Hence, a CCAP Core may receive OOB streams from multiple OMs. Each of these streams is intended for a different set of RPDs.

OM2000 does not include null frames in its Ethernet output stream. The OM provides an output of non-null packets in its Ethernet output transport streams. Hence, the downstream QPSK modulator should insert nulls when necessary. The Remote PHY device inserts null packets as necessary to maintain the required module rate of the OOB 55-1 downstream QPSK channel. The downstream modulator need not maintain precise inter-packet timing. The modulator can effectively insert null packets wherever necessary without checking for excessive data packet displacement.

Each virtual ARPD uses a unique source IP address and a unique destination UDP port in packets that are sent to the NC. The NC relies on IP address and UDP port to identify the ARPD from which the traffic is arriving.

Using GCP, the CCAP Core configures the attached RPDs with the appropriate ARPD source ID, RF port ID, and demodulator ID corresponding to each UEPI tunnel. The RPD uses this information when forming the ARPD datagram.

The RPD aggregates multiple physical demodulators into a single virtual ARPD demodulator ID.

The RPD also supports power level setting of the OOB 55-1 FDC in a range of -7 dBc to 0 dBc relative to the 256-QAM level, in 0.2 dB steps.

Forward Channels

To support the orderly transition of set-top boxes to a higher frequency, the SCTE 55-1 forward data can be carried on two forward channels with distinct frequencies. The data content sent on both channels is identical.

The RPD can support two SCTE 55-1 forward channels on any of its downstream RF port.

OOB 55-2

In the video headend, the OOB 55-2 Controller maintains all interfaces with the existing applications and services but contains only a subset of the functions available with the existing 55-2 Modulator/Demodulator. The remaining functions are moved to the RPD.

The OOB 55-2 Remote PHY solution places components necessary for performing ATM slot receipt acknowledgement within the RPD, and all other components of the OOB 55-2 MAC located in the 55-2 Controller where feasible. The OOB 55-2 Controller handles the configuration and monitoring of 55-2 specific

functions within the RPD. Some monitoring is also included in the upstream data packets sent by the RPD to the 55-2 Controller.

The current 55-2 Digital Home Communication Terminal (DHCT) service group sizes are more than 10,000 DHCTs, versus the expected RPD DHCT counts which can be 1000 or lower. For compatibility with existing infrastructure, RPDs are grouped with a single 55-2 Controller as follows:

- Multiple RPDs are bound by operator configuration to a single 55-2 Controller which can service >10,000 DHCTs.
- RPD demodulators are assigned an Upstream Group ID between 0 and 7. All demodulators in the same Upstream Group logically-share the same upstream slot assignments for 55-2 compatibility. Upstream Group ID is equivalent to SCTE 55-2 Demodulator Number, but is zero indexed instead of 1 indexed. Upstream Group ID 0 corresponds to SCTE 55-2 Demodulator Number 1 (R1), Upstream Group ID 7 corresponds to SCTE 55-2Demodulator Number 8 (R8).
- All RPDs bound to a single 55-2 Controller share a single L2TPv3 multicast tunnel for downstream data.

An RPD can incorporate a number of SCTE 55-2 modules, each represented by Oob55d2Module object. The number of SCTE 55-2 Modules is communicated using RPD capabilities. Common parameters for all 55-2 modules are grouped into an Oob55-2Config object.

Each SCTE55-2 module consists of one modulator and one to eight demodulators. The Oob55-2Modulator can be associated with one or more downstream RF ports, and the Oob55-2Demodulator can be associated with zero or one upstream RF ports.

The RPD reports these associations to the CCAP Core.

Prerequisites

The RPD must support the following:

- RPD connects to only one 55-2 controller.
- OOB 55-2 specific L2TPv3 multicast packets containing downstream ATM cells and metadata.
- OOB 55-2 specific IP and L2TPv3 encapsulation of upstream ATM cells and metadata.
- Sending at least one L2TPv3 upstream tunnel per RPD to the 55-2 Controller.
- Forwarding the IP unicast packets to the 55-2 Controller.
- GCP configuration by the 55-2 Controller using authenticated and secured connections.
- An authenticated and secured L2TPv3 control connection with the 55-2 Controller.

How to Configure 55-1 OOB

This section describes how to configure OOB on Cisco cBR-8.

Configuring Global 55-1 OOB

To configure OOB, complete the following procedure:

```
configure terminal
cable oob
virtual-om o-id
ip ip subnet_mask
join-group ip source-ip ip out-group ip
virtual-arpd id
ip ip subnet_mask
nc ip udp-port number
source-id s-id
```

Note By default, the source ID is set to **virtual-arpd ip**. If you want to configure a different value for the source ID, then configure the source ID that is applicable to the Network Controller (NC).

Caution The NC may drop upstream packets from this virtual-arpd, if the source ID is not compatible with the NC.

Configuring Profile for 55-1 OOB

To configure profile to use OOB, complete the following procedure:

```
configure terminal
controller downstream-oob 55d1-profile dp-id
no ds-channel 0 rf-mute
no ds-channel 0 shutdown
ds-channel 0 frequency f-value
ds-channel 0 poweradjust p-value
controller upstream-oob 55d1-profile up-id
no us-channel 0 shutdown
us-channel 0 frequency f-value
us-channel 0 varpd-portid va-id (ID range is 1-6) varpd-demodid vd-id
no us-channel 1 shutdown
us-channel 1 frequency f-value
us-channel 1 varpd-portid va-id varpd-demodid vd-id
no us-channel 2 shutdown
us-channel 2 frequency f-value
us-channel 2 varpd-portid va-id varpd-demodid vd-id
```

Configuring Remote PHY Device for 55-1 OOB

To configure the RPD to use OOB, complete the following procedure:

```
configure terminal
cable rpd name
identifier id
no sbfd enable
core-interface TenGigabitEthernet slot/subslot/port
principal
rpd-ds 0 downstream-oob-vom o-id profile dp-id
```

```
rpd-us 0 upstream-oob-varpd a-id profile up-id
rpd-us 1 upstream-oob-varpd a-id profile up-id
r-dti value
rpd-event profile id
```

Configuring OOB with VRF

The following example shows how to configure the OOB with VRF:

```
cable oob
  virtual-om 1
    ip 100.100.100.100 255.255.255.0 vrf xxx
    join-group 235.1.1.1 source-ip 2.3.4.5 out-group 239.2.2.2
  virtual-arpd 1
    ip 20.20.20.20 255.255.255.0 vrf xxx
    source-id 1
    nc 200.1.1.100 udp-port 100
```

Configuring Two Forward Channels

The following example shows how to configure two forward channels. This configuration is OOB DS profile: (1 port per RPD, 1 channel per port, 2 output RF frequency per channel):

```
controller downstream-oob 55d1-profile 100
     no ds-channel 0 rf-mute
     no ds-channel 0 shutdown
     ds-channel 0 frequency 70000000
     ds-channel 0 poweradjust 0
     no ds-channel 0 sf-mute
     no ds-channel 0 sf-shutdown
     ds-channel 0 second-frequency 130000000
     ds-channel 0 sf-poweradjust  -10
```

Verifying OOB DS Details

Use the following commands to verify the DS details.

```
show platform software cable F0 oob-ds

show platform software cable F0 oob-ds statistics

clear platform software cable F0 oob-ds statistics

show platform software cable F0 oob-ds group <G2 address>
```

Verifying OOB US Details

Use the following commands to verify the US details.

```
show platform software cable F0 oob-us
show platform software cable F0 oob-us statistics
clear platform software cable F0 oob-us statistics
show platform software cable F0 oob-us source-id <RPD source id>
```

Verifying OOB Channel Details

Use the following commands to view the OOB channel details.

```
show cable rpd db-dump rpd-oob-ds-chan (all)
show cable rpd db-dump rpd-oob-us-chan (all)
```

Debugging OOB

Use the following commands to view the OOB channel details.

```
debug cable rphy-oob
```

Example: OOB Configuration

The following example shows how to configure OOB:

```
Router#configure terminal
Router(config)# cable oob
Router(config-oob)# virtual-om 1
Router(config-oob-vom)# ip 100.100.100.100 255.255.255.0
Router(config-oob-vom)# join-group 235.1.1.1 source-ip 2.3.4.5 out-group 239.2.2.2
Router(config-oob-vom)# exit

Router(config-oob)# virtual-arpd 1
Router(config-oob-varpd)# ip 32.32.32.32 255.255.255.0
Router(config-oob-varpd)# nc 3.3.3.3 udp-port 100
Router(config-oob-varpd)# source-id 1
Router(config-oob-varpd)# exit
Router(config-oob)# exit

Router(config)# controller downstream-OOB 55d1-profile 1
Router(config-profile)# no ds-channel 0 rf-mute
Router(config-profile)# no ds-channel 0 shutdown
Router(config-profile)# ds-channel 0 frequency 70000000
Router(config-profile)# ds-channel 0 poweradjust 1
Router(config-profile)# exit

Router(config)# controller upstream-OOB 55d1-profile 1
Router(config-profile)# no us-channel 0 shutdown
Router(config-profile)# us-channel 0 frequency 5216000
Router(config-profile)# us-channel 0 varpd-portid 3 varpd-demodid 2
Router(config-profile)# no us-channel 1 shutdown
Router(config-profile)# us-channel 1 frequency 6000000
Router(config-profile)# us-channel 1 varpd-portid 3 varpd-demodid 4
Router(config-profile)# no us-channel 2 shutdown
Router(config-profile)# us-channel 2 frequency 8000000
Router(config-profile)# us-channel 2 varpd-portid 3 varpd-demodid 6
Router(config-profile)# exit

Router(config)# cable rpd node1
Router(config-rpd)# identifier 0004.9f00.0685
Router(config-rpd)# no sbfd enable
Router(config-rpd)# core-interface Te7/1/0
Router(config-rpd-core)# principal
Router(config-rpd-core)# rpd-ds 0 downstream-cable 7/0/0 profile 3
Router(config-rpd-core)# rpd-ds 0 downstream-oob-vom 1 profile 1
Router(config-rpd-core)# rpd-us 0 upstream-cable 7/0/0 profile 3
Router(config-rpd-core)# rpd-us 0 upstream-oob-varpd 1 profile 1
```

```
Router(config-rpd-core)# exit

Router(config-rpd)# r-dti 1
Router(config-rpd)# rpd-event profile 0
```

Feature Information for OOB

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

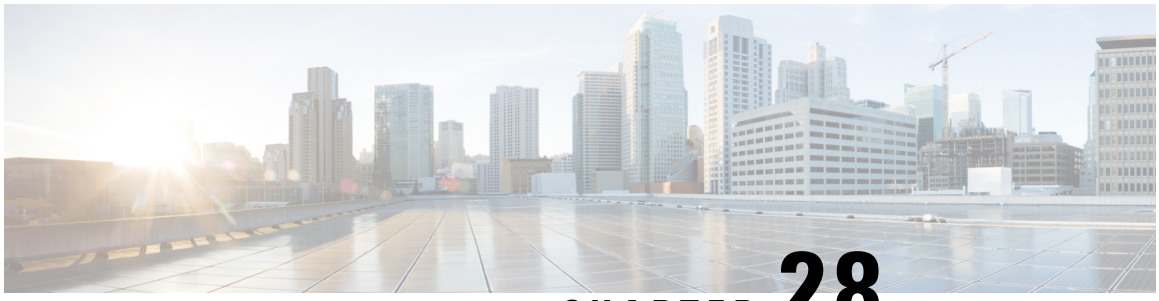
Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 54: Feature Information for OOB

Feature Name	Releases	Feature Information
Out of Band	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.
Support for OOB 55-2	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.

PART V

Remote PHY Management



CHAPTER 28

Secure Software Download

This document describes how to upgrade software from RPD and Cisco cBR by using Secure Software Download feature.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 55: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information About Secure Software Download

The secure software download (SSD) feature allows you to authenticate the source of a code file and verify the downloaded code file before using it in your system. The SSD is applicable to Remote PHY (R-PHY) devices installed in unsecure locations.

The Remote PHY architecture allows RPDs to download code. Hence, authenticating the source and checking the integrity of the downloaded code is important.

To authenticate and verify downloading of the code, SSD helps in verifying the manufacturer signature and the operator signature, if any. The manufacturer signature affirms the source and integrity of the code file to the RPD. If an additional signature is available from the operator, the RPD verifies both signatures with a certificate chain before accepting a code file.

Prerequisites for Upgrading Software using SSD

The following prerequisites are applicable to upgrading RPD software using SSD:

- The R-PHY node supports downloading software initiated through the GCP message sent from Cisco cBR.
- RPD supports a secure software download initiated using SSH and CLI directly on the RPD.
- R-PHY uses TFTP or HTTP to access the server to retrieve the software update file.

How to Upgrade Software from RPD and Cisco cBR Using SSD

Note To know more about the commands referenced in this module, see the Cisco IOS Master Command List.

Initiating RPD Software Upgrade from Cisco cBR

The RPD software upgrade can be initiated from Cisco cBR-8 Router. Use the following commands for initiating the upgrade:

```
cable rpd {all|oui|slot|RPD IP|RPD MAC} ssd server_IP {
            tftp|http} file_name [c-cvc-c|m-cvc-c]
                [CVC Chain File Name]
```

Initiating Software Upgrade from RPD Using SSD

If you want to initiate the software upgrade from RPD, set the SSD parameters on RPD. Use the following commands.

Setting the value for SSD CVC (Manufacturer's and Co-signer Code Validation Certificates) parameter is optional.

Configure the values for the following parameters

- SSD server IP address
- Filename
- Transport method

```
ssd set server server_IP filename file_name transport {tftp|http}
ssd set cvc {manufacturer|co-signer} cvc_chain_file_name
ssd control start
```

Verifying Software Upgrade Using SSD Configuration

To display the RPD SSD status, use the **cable rpd [all|oui|slot|RPD IP|RPD MAC] ssd status** command as given in the following example.

```
Router# cable rpd all ssd status
RPD-ID         ServerAddress Protocol Status            Filename
0004.9f00.0591 192.0.2.0     TFTP     ImageDownloading
image/RPD_seres_rpd_20170216_010001.itb.SSA
0004.9f00.0861 192.0.2.2     TFTP     CodeFileVerified
userid/RPD_seres_rpd_20170218_010001.itb.SSA
0004.9f03.0091 192.0.2.1    TFTP    ImageDownloadFail chuangli/openwrt-seres-rpd-rdb.itb.SSA
```

The available statuses are the following:

- CVCVerified
- CVCRejected
- CodeFileVerified
- CodeFileRejected
- ImageDownloading
- ImageDownloadSucceed
- ImageDownloadFail

- MissRootCA

Examples for Upgrading HA RPHY Software

See examples for the software upgrade from cBR-8 and FCC or Primary eRPD.

Example: HA RPHY Software Upgrade from Cisco cBR

```
Router# upgrade set server 203.0.113.1 filename bundle/test.itb.sign transport http
Router# upgrade control show config

file path: bundle/test.itb.sign
server: 203.0.113.1
transport: HTTP
Router# upgrade control start
Router# upgrade control show status.
Downloading image on FCC.


Router# cable rpd group all upgrade 203.0.113.2 http bundle/test.itb.sign
Router# cable rpd group all upgrade status
This group 0027.900a.4c1a is not HA-Shelf group.
GROUP-ID: 7abd.44a1.0000
ServerAddress: 203.0.113.2
Protocol: HTTP
Status: Image downloading on RPDLC
Filename: bundle/test.itb.sign
```

Example: HA RPHY Software Upgrade from FCC or Primary eRPD

```
Router# upgrade set server 203.0.113.2 filename bundle/test.itb.sign transport http
Router# upgrade control start
Router# upgrade control show status
Downloading image on FCC.
Router# upgrade control abort
Abort software upgrade process successfully.
Router# upgrade control show status
Image download aborted.


Router# show cable rpd-upgrade group all status
GROUP-ID: 7abd.44a1.0000
ServerAddress: 203.0.113.2
Protocol: HTTP
Status: Idle
Filename: bundle/test.itb.sign
```

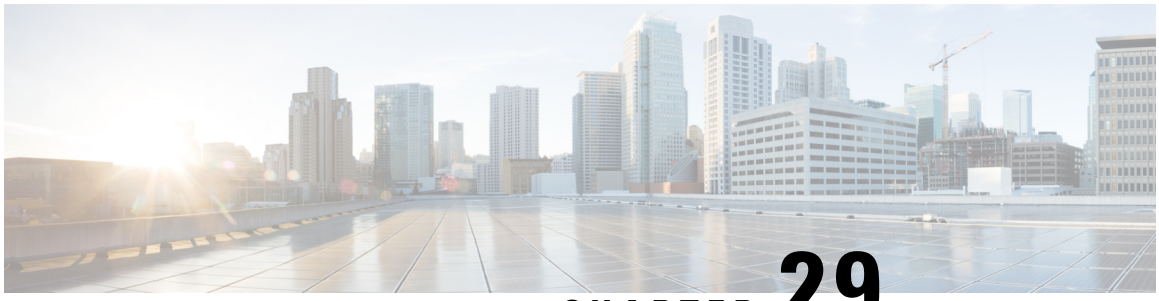
Feature Information for Secure Software Download

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 www.cisco.com/go/cfn 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 56: Feature Information for Secure Software Download

Feature Name	Releases	Feature Information
Secure Software Download	Cisco 1x2 RPD Software 1.1	This feature was introduced on the Cisco Remote PHY Device.



CHAPTER 29

Cisco Remote PHY Fault Management

This document describes how to configure the events for fault management on the Cisco cBR Series Converged Broadband Router.

Information About Fault Management

Fault management on RPD is required for remote monitoring, detection, diagnosis, reporting, and correcting the issues.

The Fault management module provides the following support:

- RPD can send events to the CCAP core
- CCAP core can get events from RPD
- Send RPD events using SNMP traps
- On the CCAP core, view log in to the CLI
- SNMP poll events are supported

RPD Event Reporting

An RPD logs events, generates asynchronous notifications that indicate malfunction situations, and notifies the operator about important events. The RPD event reporting includes two methods of reporting.

- During the initialization of RPD, CCAP core synchronizes events from the RPD.
- During run-time operations, RPD notifies the CCAP Core of the events

Restrictions for Configuring RPD Events

Following restrictions are applicable:

A maximum of 1000 events are retained on Cisco cBR. The RPD retains 1000 events locally and 1000 events in pending state.

How to Configure RPD Events

Note To know more about the commands referenced in this module, see the Cisco IOS Master Command List.

Configuring RPD Events

You can configure an event profile and apply it to RPD. Use the following commands to configure RPD events:

```
enable
configure terminal
cable profile rpd-event profile_id
  priority {emergency|alert|critical|error|warning|notice|informational|debug}
{0x0|0x1|0x2|0x3}
  enable-notify
```

- 0x0—No log
- 0x1— Save log in RPD local storage
- 0x2—Report to Cisco cBR
- 0x3— Save log in RPD local storage and report to Cisco cBR

You must enable-notifications for the RPD to report any event to the Core.

Applying the Event Profile to RPD

Use the following commands to apply the Event Profile to an RPD:

```
enable
configure terminal
cable rpd rpd_name
  rpd-event profile profile_id
```

Note If RPD is online when changing the profile, reset the RPD, after you change the profile.

Enable RPD Event Trap

You can enable RPD event traps to send RPD events using SNMP traps. Use the following commands to configure RPD event traps:

```
enable
configure terminal
snmp-server enable traps rpd-event priority
```

Priority can be 1-8, where:

- 1—Enable RPD event trap for emergency priority
- 2— Enable RPD event trap for alert priority
- 3—Enable RPD event trap for critical priority
- 4— Enable RPD event trap for error priority
- 5— Enable RPD event trap for warning priority
- 6— Enable RPD event trap for notice priority
- 7— Enable RPD event trap for informational priority
- 8— Enable RPD event trap for debug priority

The priority higher than the selected priority is also displayed.

Configure SNMP Trap Server

You can configure SNMP trap server on the cable modem using the following commands:

```
enable
cnfigure terminal
Router# snmp-server host ip_address traps version 2c public udp-port port_number
```

where,

- *ip_address*—IP address of the server
- *port_number*—UDP port number assigned to receive the SNMP traps. The same port number must also be configured on the SNMP server.

Getting RPD Events

To retrieve events from RPD, use the **cable rpd [RPD IP|RPD MAC|all] event {locallog|pending}** command, as given in the following example:

```
Router#cable rpd 30.84.2.111 event pending
```

Clearing All Events on Cisco cBR Database

To remove all Events on Cisco cBR, use the clear cable rpd all event command, as given in the following example:

```
Router#clear cable rpd all event
```

Viewing the RPD Events

To view all RPD Events, use the **show cable rpd [RPD IP|RPD MAC] event** command as given in the following example.

```
Router# show cable rpd 93.3.50.7 event
RPD            EventId    Level Count  LastTime       Message
0004.9f00.0861 66070204   Error  1     Feb21 12:11:06 GCP Connection Failure
CCAP-IP=30.85.33.2;RPD-ID=0004.9f00.0861;
0004.9f00.0861 2148074241 Error  1     Feb21 12:11:25 Session failed:connecting timeout,
@SLAVE: 93.3.50.7:None --> 30.85.33.2:8190;RPD-ID=0004.9f00.0861;
```

Viewing RPD Events Using Log

To view all RPD Events, use the show logging command, as given in the following example.

```
Router# show logging | include RPD-ID=0004.9f00.0861
004181: Feb 21 12:18:59.649 CST: %RPHYMAN-3-RPD_EVENT_ERROR:  CLC5: rphyman:
GCP Connection Failure CCAP-IP=30.85.33.2;RPD-ID=0004.9f00.0861;EVENT-ID=66070204;
FirstTime=2017-2-21,12:11:6.0;
LastTime=2017-2-21,12:11:6.0;
Count=1;PendingQueue;
004185: Feb 21 12:19:18.875 CST: %RPHYMAN-3-RPD_EVENT_ERROR:  CLC5: rphyman:
Session failed:connecting timeout, @SLAVE: 93.3.50.7:None --> 10.10.10.12:1190;
RPD-ID=0004.9f00.0861;
EVENT-ID=2148074241;
FirstTime=2017-2-21,12:11:25.0;
LastTime=2017-2-21,12:11:25.0;
Count=1;PendingQueue;
```

Configuration Examples

This section provides example for the fault management configuration on Cisco cBR-8.

Example: RPD Event Configuration

```
enable
configure terminal
cable profile rpd-event 6
    priority emergency 0x3
    priority alert 0x3
    priority critical 0x3
    priority error 0x3
    priority warning 0x3
    priority notice 0x3
    priority informational 0x3
    enable-notify
cable rpd node6
    identifier badb.ad13.5e08
    core-interface Te3/1/5
        principal
        rpd-ds 0 downstream-cable 3/0/17 profile 10
        rpd-us 0 upstream-cable 3/0/34 profile 13
    r-dti 16
    rpd-event profile 6
```

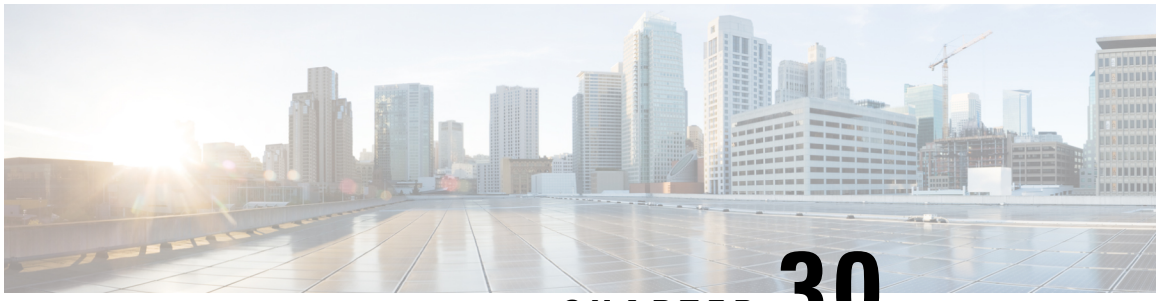
Feature Information for R-PHY Fault Management

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 www.cisco.com/go/cfn 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 57: Feature Information for R-PHY Fault Management

Feature Name	Releases	Feature Information
R-PHY Fault Management	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integated into the Cisco Remote PHY Device.



CHAPTER 30

Cisco Remote PHY Device Operations and Debugging

This document describes the RPD operations and debugging of an RPD.

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

Table 58: Hardware Compatibility Matrix for the Cisco Remote PHY Device

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	**Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2= **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—RPD-1X2-PKEY=

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Intelligent Node (iNode)	**Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases** Cisco Intelligent Remote PHY Device 1x2 • PID—iRPD-1X2= • PID—iRPD-1X2-PKEY=

Note The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

Information about RPD Operations and Debugging

The operators might need secure remote access to the RPD for activities such as setting up the RPD before the installation, maintenance, or troubleshooting. The RPD supports Secure Shell (SSH) server that allows secure access to the RPD.

Prerequisites for RPD Operations

The following prerequisites are applicable for debugging or checking RPD operations:

- RPD has established GCP connection with the CCAP-core, and RPD IP address is retrievable from CCAP-core.
- RPD is assigned an IP address through the DHCP process, and the IP address is retrievable from the DHCP server.

How to Access and Debug RPD

Note To know more about the commands referenced in this module, see the Cisco IOS Master Command List.

Accessing RPD using SSH

After logging in to the RPD for the first time, the system shows a security warning.

```
SECURITY WARNING: ssh password login is accessible!
Please use pubkey login and set password login off!
```

The following procedure shows how to use SSH to access RPD without password from NMS.

1. Check whether NMS already has an SSH key. If yes, do not generate a new key.
2. Generate a new SSH key in NMS.

```
cat ~/.ssh/id_rsa.pub
ssh-keygen -t rsa
```

3. Add the NMS public key in RPD.

```
ssh pubkey add ?
LINE          NMS's pubkey
```

4. Verify whether NMS can connect using SSH to RPD without a password.

```
ssh -l admin <RPD ip>
```

Disabling SSH Login Password

Use the following commands to apply the Event Profile to an RPD:

```
R-PHY#conf t
R-PHY(config)#ssh password ?
off                  disable ssh password login
on                   enable ssh password login
R-PHY(config)#ssh password off
R-PHY(config)#end
```

Debugging RPD

Use the following procedure to debug RPD:

1. Disable RPD auto reboot by setting the reboot hold.

```
R-PHY# set reboot hold
```

2. Secure copy the logs of RPD to the server using the following command.

```
logging provision-archive scp server_ip user_id dst_location
```

3. Collect the show CLI output.

   For RPD online issues, check which status is failed. You can check the following outputs:

   - show provision all
   - show provision history
   - show dot1x detail
   - show dhcp
   - show tod
   - show ptp clock 0 config
   - show ptp clock 0 state

   For modem online issue, check ds/us config and l2tp session.

   You can collect the following outputs:

   - show downstream channel configuration
   - show downstream channel counter dps (show multiple times)

- show downstream depi configuration
- show upstream channel configuration <port number> <channel number>
- show upstream iuc counter <port number> <channel number> (show multiple times)
- show upstream map counter <port number> <channel number> (show multiple times)
- show upstream uepi configuration
- show l2tp tunnel
- show l2tp session

4. Enable RPD auto reboot, after collecting all logs and CLI output.

```
R-PHY#clear reboot hold
```

Verifying Disabled SSH Password Login

To check whether the SSH logging in using a password is disabled, use the show ssh session command as given in the following example.

```
R-PHY#show ssh session
connected session: 1
ssh password auth: off
ssh NMS pubkey num: 1
R-PHY#
```

Configuration Examples

This section provides example for the fault management configuration on R-PHY.

Example: Generating a New NMS pubkey

```
$ cat ~/.ssh/id_rsa.pub

$ ssh-keygen -t rsa

$ cat ~/.ssh/id_rsa.pub
ssh-rsa AAAAB3NzaC1yc2EAAAABIwAAAgEAtQCXVFmRIwemejbTx0+U8taMq5n4Zetu
71xb+dtHV8Rr0wejiK1YJkT93n9hcBxsjHRu76bLp99l+DDNL3+THljwnMQC1CsdvRmGXoe
Gf1mT9aTlGDf/ RW9ZywY9t8Kep9VnANu2DWSoh0wg2pE49HFOJAbGfuFOvPEdwZGGDMQNWs
Eq/3xAQjBxajQqfgu4IqjVzKoo4PM/xx9X4Z1aMwxS3DvyN7L8O0o33mcDNsasl3SslIjMSNfq
YpwOFvQve8c2onrYHUx2p3BwQOb/b0FzFQhZMTBXm/pDMXq/fkkD0uguk1xOGnqAATMJsSHIN
0UOdvbzhhmrFRBBM4NzqQG5kNt7KvnWgxE7HdalERvMyBC2MCGbFSHmQFyWmHBHPPmLIxK98W
XutoR8fzzs+4hingZ4X9DMMNwTQ6WOzjuKq6iU= userid@example.cisco.com
```

Example: Adding NMS pubkey in RPD

```
R-PHY#conf t
R-PHY(config)#ssh pubkey add ?
LINE                 NMS's pubkey
R-PHY(config)#ssh pubkey add ssh-rsa AAAAB3NzaC1yc26876bhjdsk
EEEAAAABIwAAAgErP3nFp0v0k3Nf4UvSTuOOQi2h0mAfAtQCXVFmRIwemejbTx0+U8taM
```

```
q5n4Zetu71xb+dtHV8Rr0wejiK1YJkT93n9hcBxsjHRu76bLp99l+DDNL3+THljwnMQC1
CsdvRmGXoeGf1mT9aTlGDf/YfKxZMozMnR9qlGJFXlRAwGMsCRlllnV6IkFyh59P9Udkd
SSWv+QL8lCftWBmMnyt/CkqL98NK0Vp0gIYRv7UKCwhK40c8X7PhzxCmKVFTUv3bf9VIP
NA2esgzKDFpoJZkqCjrnXU1Xu0Oj8Twci7f0ytSrFxVKuWp4XZbVDpWGH90BOQR8gKHmq
urP3nFp0v0k3Nf4UvSTuOOQi2h0mAf+9wzm+ab41ToadUbMawHyFYyuU= xxx@xxx.xxx.com
R-PHY(config)#end

R-PHY#show ssh nms-pubkey ssh-rsa AAAAB3NzaC1yc2EAAAABIwAAAgEAtQCXVFm
RIwemejbTx0+U8taMq5n4Zetu71xb+dtHV8Rr0wejiK1YJkT93n9hcBxsjHRu76bLp99l
+DDNL3+THljwnMQC1CsdvRmGXoeGf1mT9aTlGDf/YfKxZMozMnR9qlGJFXlRAwGMsCRll
lnV6IkFyh59P9UdkdSSWv+QL8lCftWBmMnyt/CkqL98NK0Vp0gIYRv7UKCwhK40c8X7Ph
zxCmKVFTUv3bf9VIPNA2esgzKDFpRvMyBC2MCGbFSHmQFyWmHBHPPmLIxK98WXutoR8fzz
s+4hingZ4X9DMMNwTQ6WOzjuKq6iU= xxx@xxx.xxx.com
```

Feature Information for RPD Operations and Debugging

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 www.cisco.com/go/cfn 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 59: Feature Information for RPD Operations and Debugging

Feature Name	Releases	Feature Information
RPD Operations and Debugging	Cisco 1x2 / Compact Shelf RPD Software 3.1	This feature was integrated into the Cisco Remote PHY Device.