Cisco Remote PHY System Startup Configuration for Cisco 1x2 / Compact Shelf RPD Software 6.x

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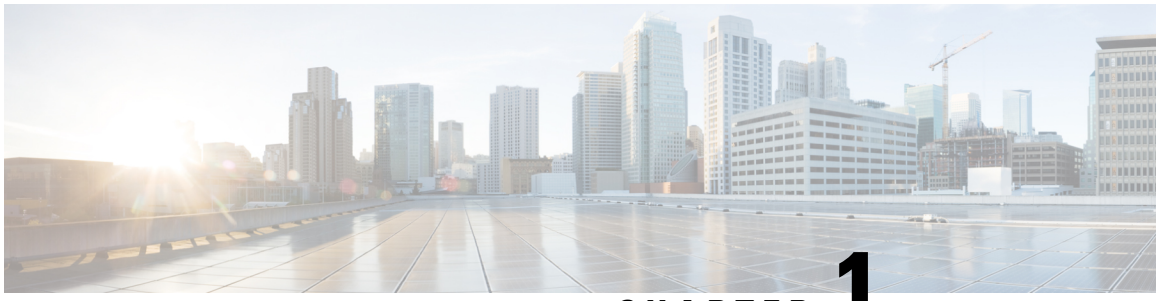

CHAPTER 1

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—HA Shelf **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—HA Shelf-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. 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.

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

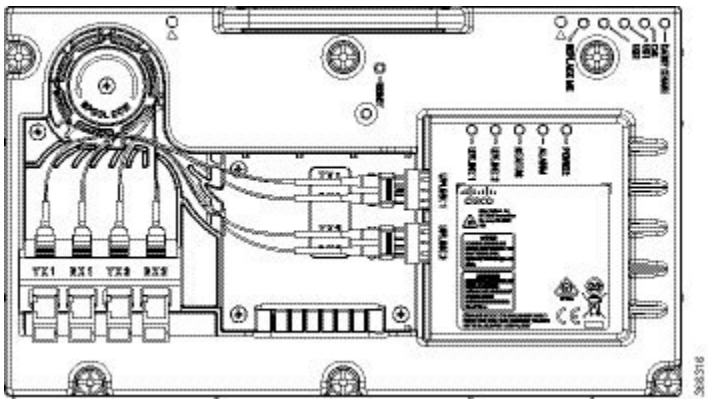
Cisco Remote PHY Device

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.

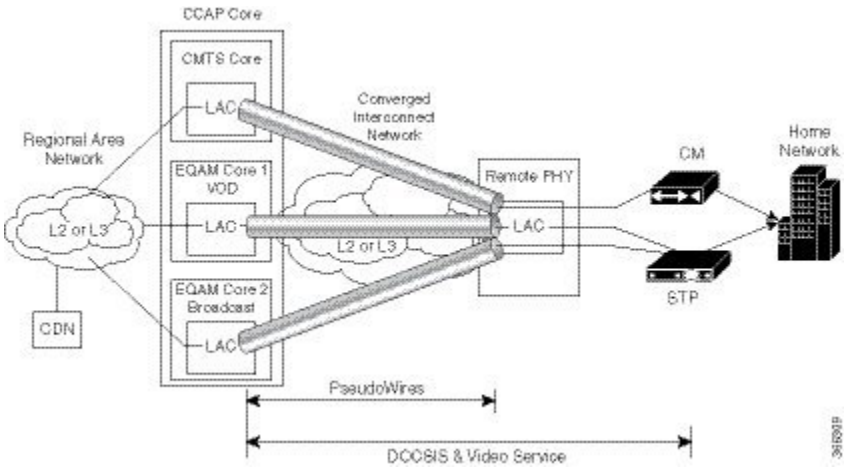
Figure 1: Cisco RPD



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.

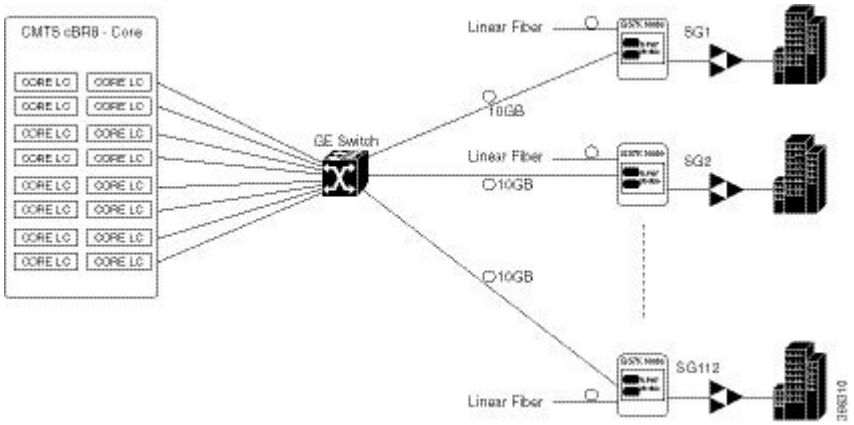
Figure 2: Single Controller Sharing Architecture



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.

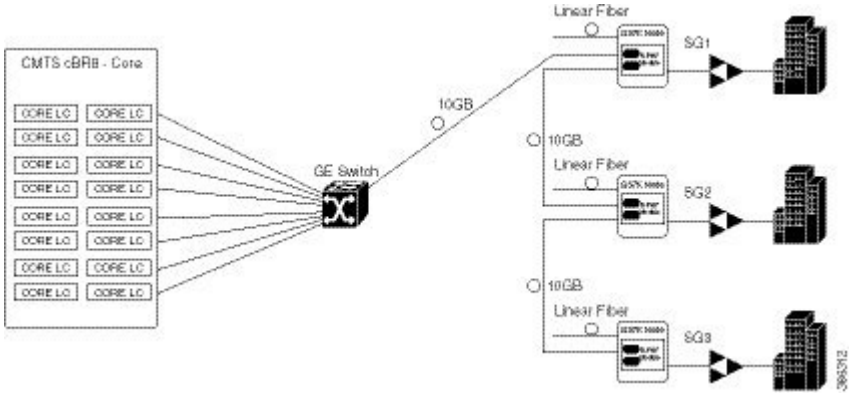
Other Supported Topologies

Figure 4: Path Redundancy Deployment

Daisy Chain Architecture

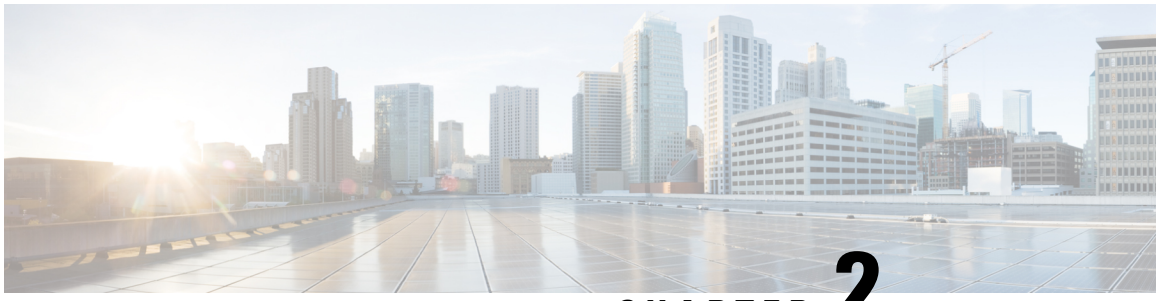
Cisco Remote PHY devices support the daisy chain architecture. The daisy chain architecture includes multiple RPDs connected in series. This daisy chaining topology is transparent to CCAP core. The CCAP core is not notified about the chain topology because before the RPD sets up a GCP connection, notification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

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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 Bring Up

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

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

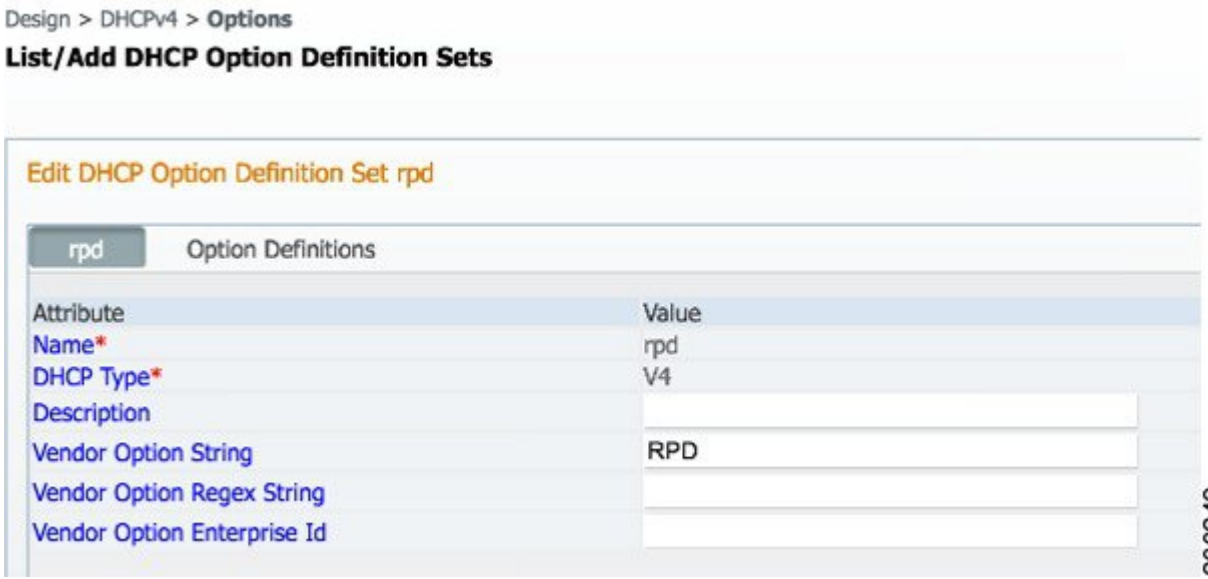
Configuring DHCP Server

You can choose to configure the DHCP server using any of the following methods.

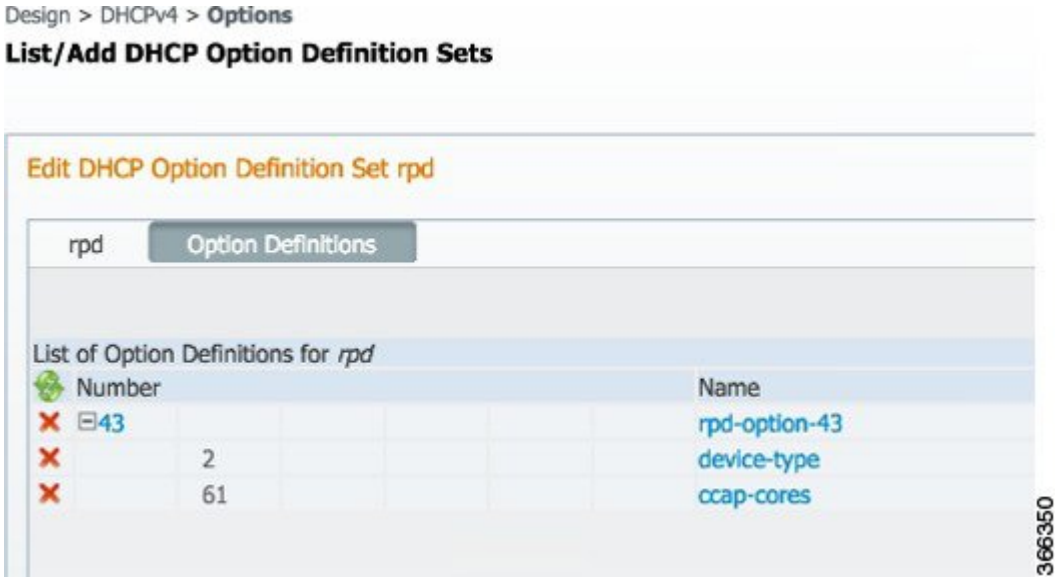
Configuring DHCP Server using IPv4

To configure DHCP server using IPv4, follow the steps below:

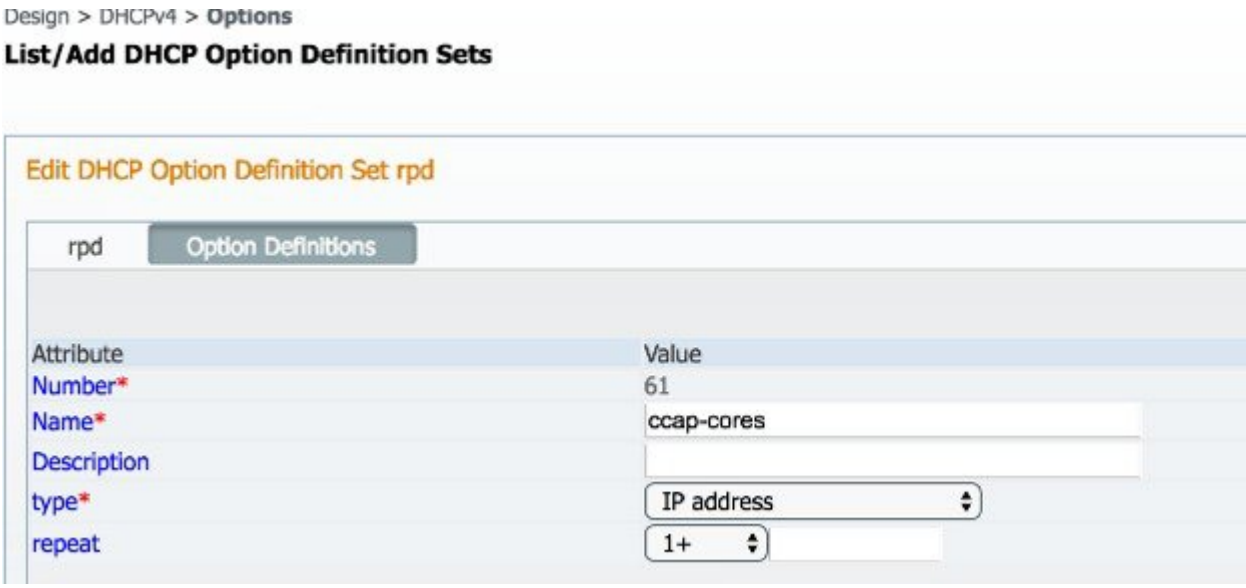
1. Add option for CCAP-Core. Fill in the name, DHCP type, and vendor option string as shown in the figure below.



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



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



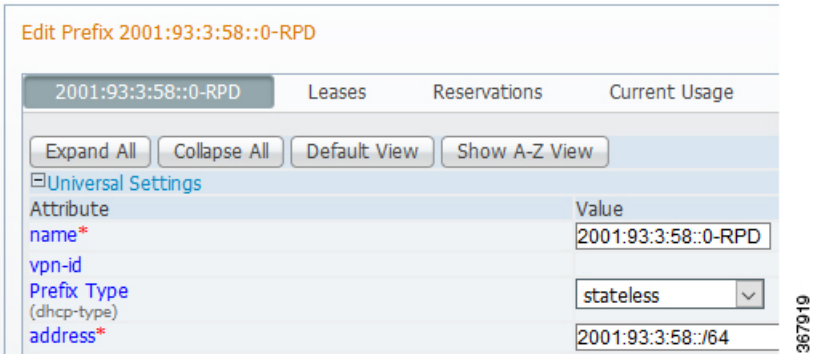
4. Add the option into policy as shown in the following figure. Replace the IP address 120.102.15.1 in the figure to the DPIC port IP address.

Configuring DHCP Server using IPv6 Stateless

The Cisco Remote PHY System supports the Stateless Address Auto Configuration (SLAAC). IPv6 address assignment of the RPD is governed by the configuration bits set in the ICMPv6 Router Advertisement (RA) message and the presence of a valid prefix in the Prefix Information Option (PIO). For more information about RPD IPv6 address assignment, refer to section 6.7 of Remote PHY Specification.

To configure DHCP server using IPv6 Stateless and enable SLAAC, follow the steps below:

1. Configure Prefix Type to “stateless” in CNR prefix.
2. Configure ICMPv6 Router RA message M Bit=0 and O Bit =1.



Note It is recommended that you follow the DHCP options listed in *Table 2 - Router Advertisement M Bit and O Bit Settings For SLAAC* of section 6.7.1 (CM-SP-R-PHY-I10) or 6.6.1 (CM-SP-R-PHY-I11) in the Remote PHY Specification.

To display the RPD get IPv6 address by SLAAC, use the **show dhcp** command.

```
R-PHY#show dhcp
Interface  IP-Address                          Subnet-Mask
vbh0       2001:93:3:58:1204:9fff:fec1:100  ffff:ffff:ffff:ffff::

Details:
------------------------------------------------------------------------------
Interface:                    vbh0
AddrType:                     IPv6<Stateless>
TimeServers:                  2001:20:1:1::33
TimeOffset:                   28800
LogServers:                   2001:20:1:1::33
CCAPCores:                    2001:93:3:58::1
```

Configuring DHCP Server using IPv6 Stateful

To configure DHCP server using IPv6 Stateful, follow the steps below:

1. Configure Prefix Type to “dhcp” in CNR prefix. See the following image.
2. Configure ICMPv6 Router RA message M Bit=1.

To display the RPD get IPv6 address by Stateful method, use the **show dhcp** command.

```
R-PHY#show dhcp
Interface  IP-Address                          Subnet-Mask
```

```
vbh0       2001:93:3:58::d8  ffff:ffff:ffff:ffff::

Details:
--------------------------------------------------------------------------------
Interface:                    vbh0
AddrType:                     IPv6<Stateful>
TimeServers:                  2001:20:1:1::33
TimeOffset:                   28800
LogServers:                   2001:20:1:1::33
CCAPCores:                    2001:93:3:58::1
```

Configuring PTP

To configure PTP, use the following example as reference:

On the Cisco 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 primary clock:

```
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
```

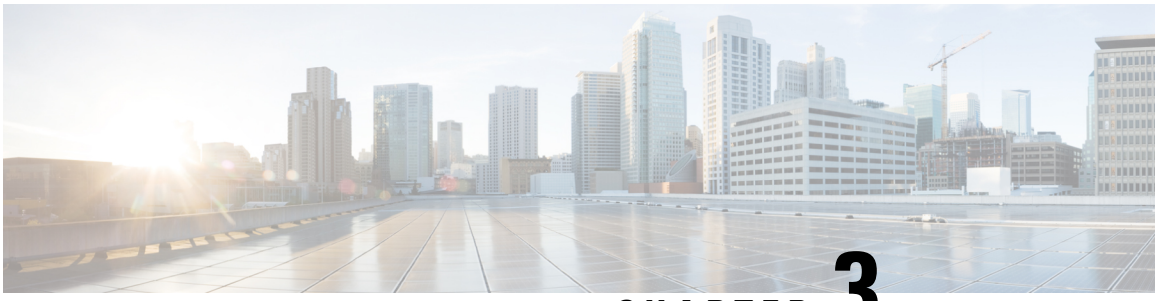
```
  rewrite ingress tag pop 1 symmetric
  bridge-domain 32
interface BDI31   /* for cBR, SUP PIC */
 ip address 192.104.10.93 255.255.255.0
 no shut
interface BDI32   /* For RPD */
 ip address 93.3.10.2 255.255.255.0
 no shut

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
  rpd-55d1-us-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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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:

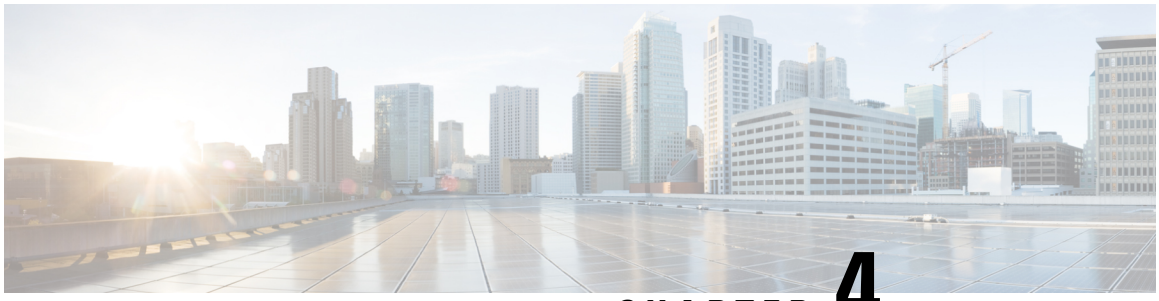
```
authentication port-control auto
dot1x pae authenticator
```

Verifing 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.

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 4: 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—HA Shelf **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—HA Shelf-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) subordinate mode, in which the PTP suborinate 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-8.

- Cisco cBR-8 supports PTP subordinate on both SUP-PIC and DPIC.

- Cisco RPD PTP does not support pass-through mode. Pass-through mode means RPDs are communicating with PTP server through cBR-8, and cBR-8 is PTP unware of the communication between RPDs with PTP server.

How to Configure Time Synchronization

Configure 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 5: 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, subordinate primary	subordinate
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
rpd-55d1-us-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
 rpd-55d1-us-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: Configure 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 primary)
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 primary 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 primary 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
 rpd-55d1-us-event profile 0
```

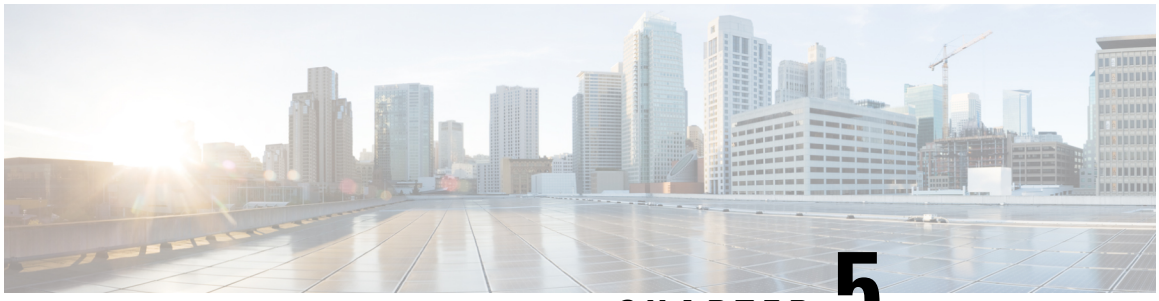
Feature Information for Synchronizing Time on R-PHY Devices

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 6: 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 7: 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—HA Shelf **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—HA Shelf-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 depi-class/l2tp-class Pair Configuration

To verifying depi-class/l2tp-class pair configuration, use the **show running-config** command as shown in the example below:

```
Router# show running-config | section rpd
alias exec scr show cable rpd
cable rpd node
identifier 0004.9f00.0901
core-interface Te1/1/7
  principal
  rpd-ds 0 downstream-cable 1/0/31 profile 155
  rpd-us 0 upstream-cable 1/0/63 profile 100
  depi depi_demo
r-dti 1
rpd-event profile 0
rpd-55d1-us-event profile 0
```

When the RPD core is online, use the **show l2tp tunnel** command as shown in the example below:

```
Router# show l2tp tunnel
LocTunID   RemTunID   Remote Name   State  Remote Address  Sessn L2TP Class/
                                                          Count VPDN Group
2375973187 4191827509 OpenRPD       est    120.100.1.20    86    l2tp_demo
2982856686 2223617345 OpenRPD       est    120.100.1.20    86    l2tp_demo
```

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 Related 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 8: 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.

Field	Description
est in State	Established state.
P in Type	On primary line card.

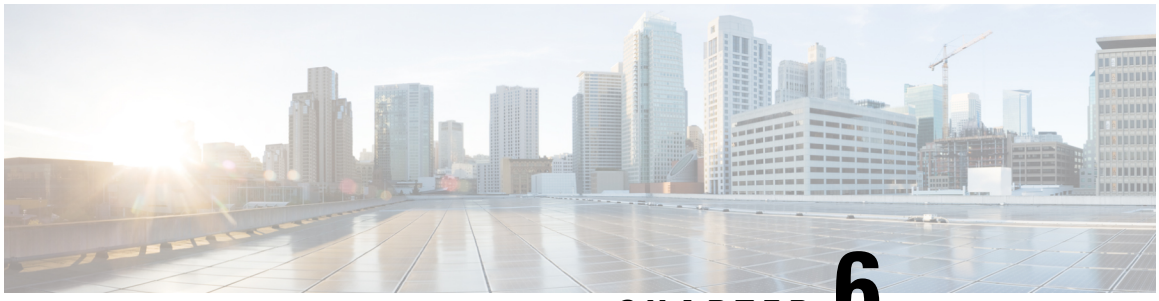
Feature Information for DEPI/UEPI/L2TP integration with RPD

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 9: 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 10: 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—HA Shelf **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—HA Shelf-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 11: 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
```

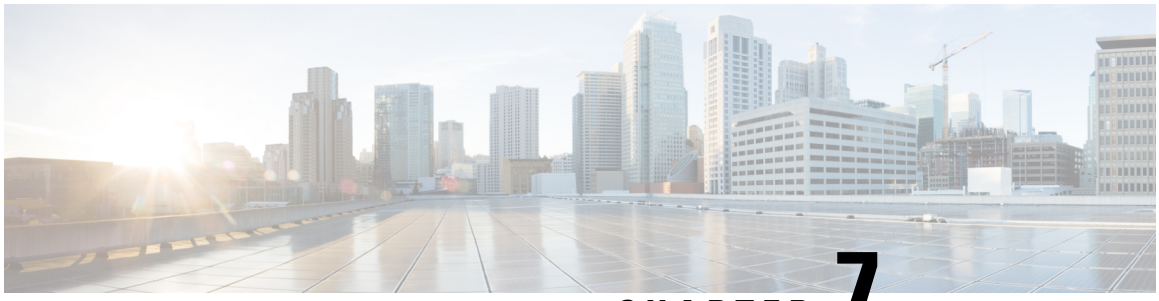
Feature Information for DLM

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 12: 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 13: 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—HA Shelf **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—HA Shelf-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:

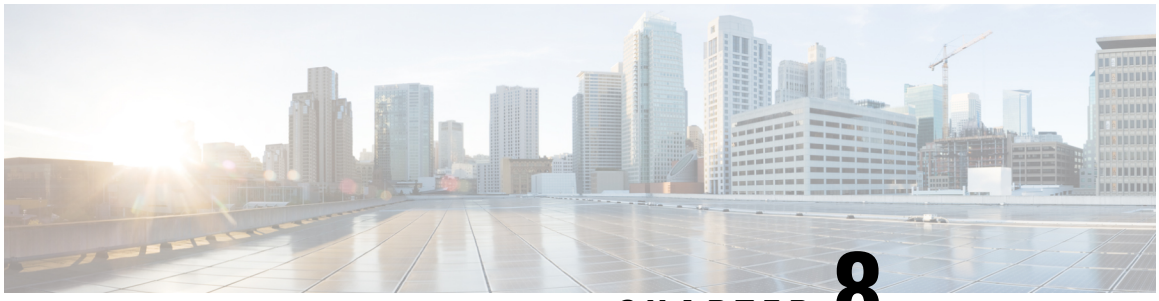
```
Router(config)# cable rpd sjc_block22   /* unique name for each rpd */
Router(config-rpd)# description rpd for sjc block 22
Router(config-rpd)# identifier 1122.3344.5566   /* unique id for each rpd.*/
Router(config-rpd)# rpd-ds 0 power-level 5   /* DS max-carrier and power-level info */
Router(config-rpd)# 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
Router(config-rpd)# rpd-55d1-us-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.

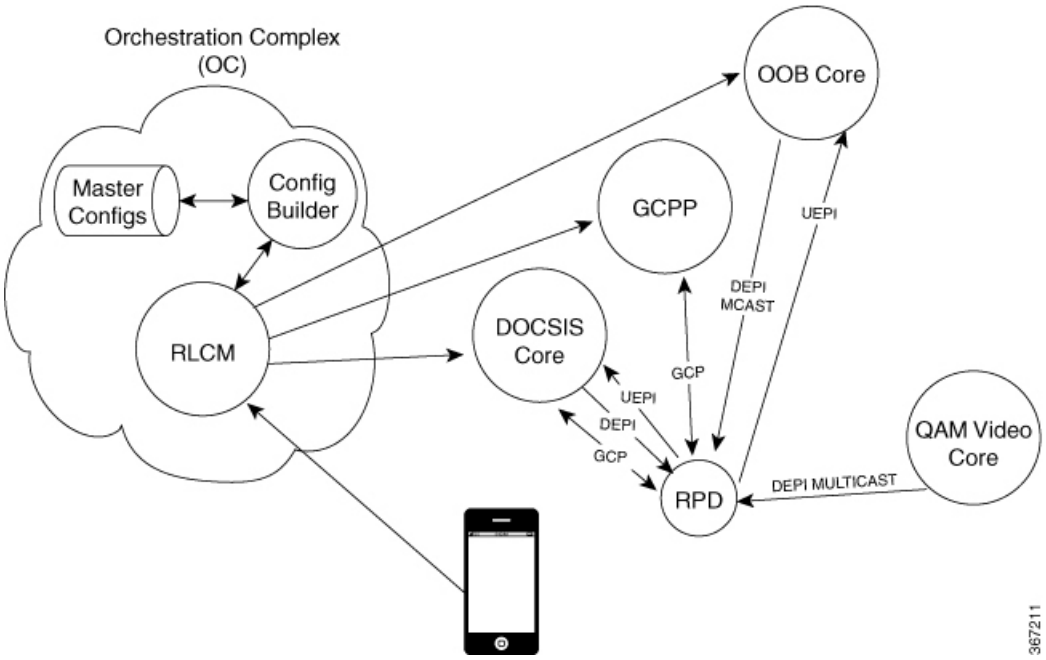
Information About GCPP Support

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 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—HA Shelf **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—HA Shelf-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

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>
 rpd-55d1-us-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
 rpd-55d1-us-event profile 0
```

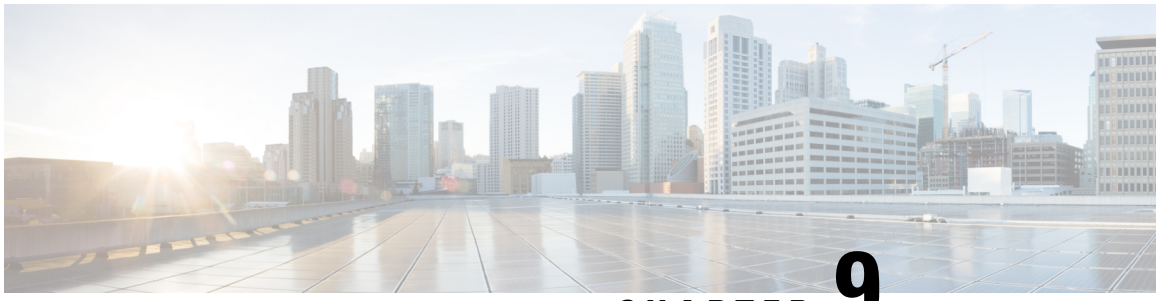
Feature Information for GCPP Support

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 15: 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 16: 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—HA Shelf **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—HA Shelf-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.

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
```

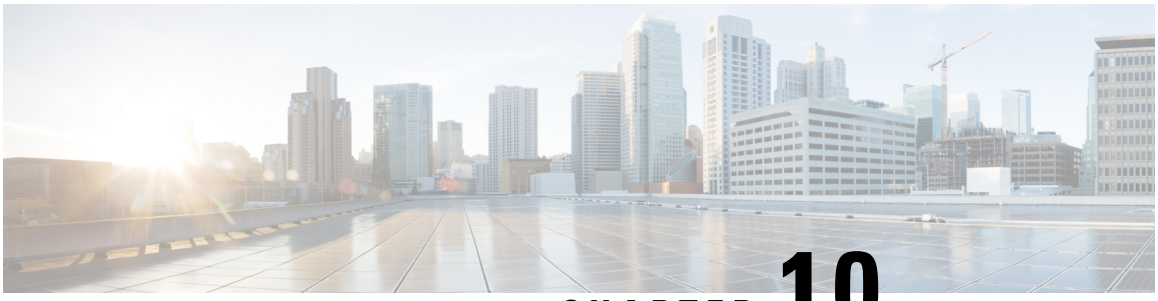
Feature Information for IKEv2 Mutual Authentication

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 17: 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 18: 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—HA Shelf **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—HA Shelf-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

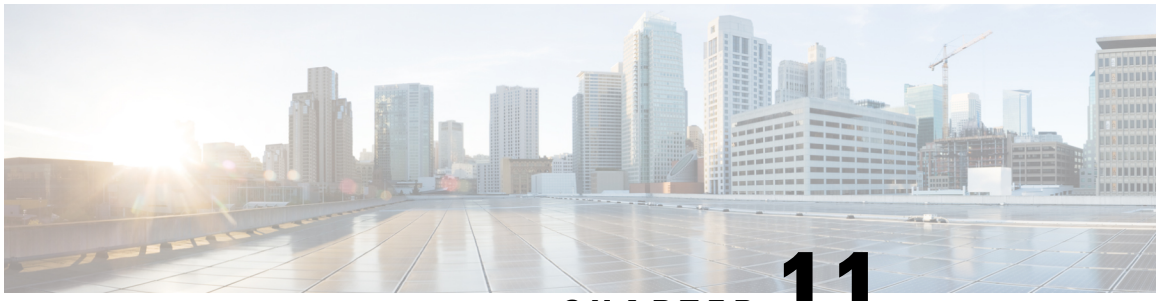
```
configure terminal
cable rpd name
rpd-ds port rf-channel number power-adjust value
```

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
```



CHAPTER 11

Link Layer Discovery Protocol

This document describes how to display the RPD LLDP neighbors and counters information. It also describes how to use the **show lldp neighbors/statistics** command.

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—HA Shelf **Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases** Cisco Remote PHY Device 1x2 • PID—HA Shelf-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.

Link Layer Discovery Protocol

LLDP (Link Layer Discovery Protocol) is a vendor-neutral link layer protocol in the Internet Protocol Suite used by network devices for advertising their identities and capabilities on an IEEE 802 local area network, principally wired Ethernet.

In Cisco 1x2 / Compact Shelf RPD Software 6.1, LldpEnable TLV is introduced to enable or disable the LLDP protocol.

This TLV will be documented in a forthcoming revision of the Cablelabs Remote PHY Specification. The TLV Type is 15.6.1. A Boolean value is defined to enable/disable LLDP operation on the RPD. 0 means LLDP is disabled. 1 means LLDP is enabled. Default value is 1.

Displaying LLDP Status

To display RPD LLDP neighbors and counters information, use **show lldp neighbors/statistics** command as shown in the following example.

```
R-PHY#show lldp neighbors
------------------------------------------------------------------------------
LLDP neighbors:
```

```
-------------------------------------------------------------------------------
Interface:    eth0, via: LLDP, RID: 1, Time: 0 day, 21:10:24
  Chassis:
    ChassisID:    mac 00:1c:0e:82:c3:26
    SysName:      K02-NM-SW.cisco.com
   SysDescr:    Cisco IOS Software, C2960 Software (C2960-LANBASEK9-M), Version 12.2(37)SE,
 RELEASE SOFTWARE (fc2)
                 Copyright (c) 1986-2007 by Cisco Systems, Inc.
                 Compiled Thu 10-May-07 16:43 by antonino
    MgmtIP:       10.74.54.231
    Capability:   Bridge, off
    Capability:   Router, off
  Port:
    PortID:       local Fa0/38
    PortDescr:    FastEthernet0/38
-------------------------------------------------------------------------------
Interface:    vbh0, via: LLDP, RID: 2, Time: 0 day, 04:12:02
  Chassis:
    ChassisID:    mac 00:de:fb:95:17:01
    SysName:      Cloud-Leaf-C
    SysDescr:    Cisco NX-OS(tm) n6000, Software (n6000-uk9), Version 7.3(3)N1(1), Interim
 version 7.3(3)N1(0.535), RELEASE SOFTWARE Copyright (c) 2002-2012, 2016-2017 by Cisco
Systems, Inc. Compiled 11/18/2017 2:00:00
    MgmtIP:       10.74.54.173
    Capability:   Bridge, on
  Port:
    PortID:       local Eth1/26
    PortDescr:    Ethernet1/26
  UnknownTLVs:
    TLV:          OUI: 00,01,42, SubType: 1, Len: 1 01
    TLV:          OUI: 00,01,42, SubType: 2, Len: 16
24,00,24,00,24,00,24,00,24,00,24,00,24,00,24,00
    TLV:          OUI: 00,01,42, SubType: 6, Len: 4 06,00,00,00
-------------------------------------------------------------------------------

R-PHY#show lldp statistics
-------------------------------------------------------------------------------
LLDP statistics:
-------------------------------------------------------------------------------
Interface:    eth0
  Transmitted:  5099
  Received:     3818
  Discarded:    0
  Unrecognized: 6
  Ageout:       0
  Inserted:     2
  Deleted:      0
-------------------------------------------------------------------------------
Interface:    vbh0
  Transmitted:  2548
  Received:     2554
  Discarded:    6
  Unrecognized: 8
  Ageout:       0
  Inserted:     1
  Deleted:      0
-------------------------------------------------------------------------------
```

If the LLDP is disabled, the output of the **show lldp statistics** command will be:

```
R-PHY#show lldp statistics
lldp disabled
```

Feature Information for LLDP

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 20: Feature Information for LLDP

Feature Name	Releases	Feature Information
LLDP	Cisco 1x2 / Compact Shelf RPD Software 5.4	This feature was integrated into the Cisco Remote PHY Device.
Disable LLDP by TLV	Cisco 1x2 / Compact Shelf RPD Software 6.1	This feature was integrated into the Cisco Remote PHY Device.