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PART

Cisco Remote PHY System Overview

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Finding Feature Information

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CHAPTER 2

Cisco Remote PHY System Overview

Finding Feature Information

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• Hardware Compatibility Matrix for Cisco Remote PHY Device, on page 4
• Benefits, on page 5
• Cisco CCAP RF Line Card for R-PHY, on page 5
• Cisco Digital Physical Interface Card, on page 5
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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>
<thead>
<tr>
<th><strong>Cisco HFC Platform</strong></th>
<th><strong>Remote PHY Device</strong></th>
</tr>
</thead>
<tbody>
<tr>
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<td>Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2=</td>
</tr>
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</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2-PKEY=</td>
</tr>
<tr>
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<td>and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Intelligent Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td>• PID—iRPD-1X2-PKEY=</td>
</tr>
</tbody>
</table>
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 eBR router and conforms to the Integrated CMTS (I-CMTS) architecture. The PID is eBR-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

<table>
<thead>
<tr>
<th>Unit</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>10.96 in (27.8cm)</td>
</tr>
<tr>
<td>Height</td>
<td>1.43 in (3.6cm)</td>
</tr>
<tr>
<td>Depth</td>
<td>7.32 in (18.6cm) with handle</td>
</tr>
<tr>
<td>Weight</td>
<td>2.943 lb (1.335kg)</td>
</tr>
</tbody>
</table>

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
- 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.
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
PART II

Cisco Remote PHY System Bring Up

• Cisco Remote PHY System Bring Up, on page 11
Chapter 3

Cisco Remote PHY System Bring Up

Finding Feature Information

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- Hardware Compatibility Matrix for Cisco Remote PHY Device, on page 11
- Information about RPD Bring Up, on page 12
- How to Bring Up RPD, on page 12

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 3: Hardware Compatibility Matrix for the Cisco Remote PHY Device

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</tr>
</tbody>
</table>

11
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:

Procedure

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:

```bash
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
```
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 16000000 16000000
  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
PART III

Remote PHY Provisioning

- Network Authentication, on page 19
- Synchronizing Time on Cisco Remote PHY Devices, on page 25
- DEPI/UEPI/L2TP integration with Cisco Remote PHY Device, on page 37
- DEPI Latency Measurement, on page 41
- Multiple Cores, on page 45
Network Authentication

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

Finding Feature Information

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- Information about Network Authentication, on page 20
- How to Enable Network Authentication, on page 21

Hardware Compatibility Matrix for Cisco Remote PHY Device

Note

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<td></td>
<td>Cisco Intelligent Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—iRPD-1X2=</td>
</tr>
<tr>
<td></td>
<td>• PID—iRPD-1X2-PKEY=</td>
</tr>
</tbody>
</table>

**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:

Procedure

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Combine CA certificate for AAA server.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>cat spCA.pem caRoot.pem &gt; ca_root_srv.pem</td>
</tr>
</tbody>
</table>

| 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:

Procedure

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Define a new client in /etc/freeradius/clients.conf.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>client rphytest_ng13 {</td>
</tr>
<tr>
<td></td>
<td>ipaddr = 20.5.0.36</td>
</tr>
<tr>
<td></td>
<td>secret = rphytest</td>
</tr>
<tr>
<td></td>
<td>shortname = ng13_switch</td>
</tr>
<tr>
<td></td>
<td>require_message_authenticator = yes</td>
</tr>
<tr>
<td>}</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Step 2</th>
<th>In &quot;/etc/freeradius/eap.conf&quot;, change the following lines in &quot;tls&quot; to specify the server's private key file and certificate files.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>tls {</td>
</tr>
<tr>
<td></td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>private_key_file = $(certdir)/aaa.key</td>
</tr>
<tr>
<td></td>
<td>certificate_file = $(certdir)/aaaCert.pem</td>
</tr>
<tr>
<td></td>
<td>CA_file = $(cadir)/ca_root_srv.pem</td>
</tr>
<tr>
<td>}</td>
<td></td>
</tr>
</tbody>
</table>

| 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.

---

**Procedure**

**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
```
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=0d53798f5b46014cc92a4ac1151521bae6a14c98f919eb5e8c81a701b7272be7f812e7e5a75881768d74d311795a3b1f0e37bfa7fff7c685d36f216bec59850
uuid=ab722cfb-84dc-5835-a905-edfec20f78c3
Verifying Authentication Status
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, on page 25
- Information about Time Synchronization, on page 26
- How to Configure Time Synchronization, on page 27
- Configuration Examples, on page 34
- Feature Information for Synchronizing Time on R-PHY Devices, on page 35

### Hardware Compatibility Matrix for Cisco Remote PHY Device

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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 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

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
clock-port slave-from-903 slave
delay-req interval -4
clock-port slave-from-903 slave
sync interval -5
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**

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

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

## Verifying Time Interface and PTP Domain Configuration

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

```plaintext
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
```
# 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 Interval : -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-DTI the 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-da 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 ipcc 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
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: 5%
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
Name Tx Mode Role Transport State Sessions Port Addr
slave-from-903 unicast slave L01588 Slave 2 10.10.10.11

SESSION INFORMATION
slave-from-903 [L01588] [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 :
master ip : 10.10.10.11
stream state : PHASE_LOCK
Master offset : -405
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 :
  280-00:06:51.568 180-00:06:41.930 080-00:04:17.925
  480-00:03:58.724
ClockState  5 :
  580-00:07:12.640 480-00:07:10.182 380-00:07:06.825
  280-00:06:51.825 180-00:06:51.530
BstPktStrm  1 :
  080-00:06:42.029
SetTime  1 :
  100000000000-00:00:04:00.045
StepTime  1 :
  1251267580-00:06:14.670
AdjustTime  64 :
streamId msgType rx rxProcessed lost tx
  0      SYNC    433439    433439    0     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    4294547085   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 dsdp 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
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.

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>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synchronizing Time on R-PHY Devices</td>
<td>Cisco 1x2 RPD Software 1.1</td>
<td>This feature was introduced on the Cisco Remote PHY Device.</td>
</tr>
</tbody>
</table>
Feature Information for Synchronizing Time on R-PHY Devices
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/. You do not require a cisco.com login account.

- Hardware Compatibility Matrix for Cisco Remote PHY Device, on page 37
- Information about DEPI/UEPI/L2TP integration with RPD, on page 38
- How to Configure DEPI/UEPI/L2TP integration with RPD, on page 38
- Feature Information for DEPI/UEPI/L2TP integration with RPD, on page 40

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

<table>
<thead>
<tr>
<th>Cisco HFC Platform</th>
<th>Remote PHY Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco GS7000 Super High Output Node</td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2=</td>
</tr>
<tr>
<td></td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2-PKEY=</td>
</tr>
<tr>
<td>Cisco GS7000 Super High Output Intelligent Node (iNode)</td>
<td>and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Intelligent Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—iRPD-1X2=</td>
</tr>
<tr>
<td></td>
<td>• PID—iRPD-1X2-PKEY=</td>
</tr>
</tbody>
</table>

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 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 0x000000B2 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
```
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

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEPI/UEPI/L2TP integration with RPD</td>
<td>Cisco 1x2 RPD Software 1.1</td>
<td>This feature was introduced on the Cisco cBR Series Converged Broadband Routers.</td>
</tr>
</tbody>
</table>
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/. You do not require a cisco.com login account.

• Hardware Compatibility Matrix for Cisco Remote PHY Device, on page 41
• Information about DEPI Latency Measurement, on page 42
• How to Configure DLM, on page 42
• Example: DLM Configuration, on page 43
• Feature Information for DLM, on page 43

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

<table>
<thead>
<tr>
<th>Cisco HFC Platform</th>
<th>Remote PHY Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco GS7000 Super High Output Node</td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2=</td>
</tr>
<tr>
<td></td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2-PKEY=</td>
</tr>
<tr>
<td>Cisco GS7000 Super High Output Intelligent Node (iNode)</td>
<td>and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Intelligent Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—iRPD-1X2=</td>
</tr>
<tr>
<td></td>
<td>• PID—iRPD-1X2-PKEY=</td>
</tr>
</tbody>
</table>

**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
```
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)
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>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last Average DLM</td>
<td>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.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEPI Latency Measurement</td>
<td>Cisco 1x2 RPD Software 1.1</td>
<td>This feature was introduced on the Cisco cBR Series Converged Broadband Routers.</td>
</tr>
</tbody>
</table>
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/. You do not require a cisco.com login account.

- Hardware Compatibility Matrix for Cisco Remote PHY Device, on page 45
- Information about Multiple Cores, on page 46
- How to Configure Multiple Cores, on page 47

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

<table>
<thead>
<tr>
<th>Cisco HFC Platform</th>
<th>Remote PHY Device</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cisco GS7000 Super High Output Node</strong></td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2=</td>
</tr>
<tr>
<td></td>
<td><strong>Cisco GS7000 Super High Output Intelligent Node (iNode)</strong></td>
</tr>
<tr>
<td></td>
<td>Cisco Intelligent Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—iRPD-1X2=</td>
</tr>
<tr>
<td></td>
<td>• PID—iRPD-1X2-PKEY=</td>
</tr>
</tbody>
</table>

- **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 multiple 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 downstream 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:

```plaintext
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:

```plaintext
Router# show cable rpd
MAC Address IP Address I/F State Role HA Name
0004.9f00.0907 120.100.2.20 Tel1/6 online Pri Act node
0004.9f00.0907 120.100.2.20 Tel1/0 online Aux Act node
```
Verifying Multiple Cores Configuration

<table>
<thead>
<tr>
<th>MAC Address</th>
<th>IP Address</th>
<th>Port</th>
<th>Status</th>
<th>Role</th>
<th>Node</th>
</tr>
</thead>
<tbody>
<tr>
<td>0004.9f00.0907</td>
<td>120.100.2.20</td>
<td>Tel/1/1</td>
<td>online</td>
<td>Aux</td>
<td>Act</td>
</tr>
<tr>
<td>0004.9f00.0907</td>
<td>120.100.2.20</td>
<td>Tel/1/2</td>
<td>online</td>
<td>Aux</td>
<td>Act</td>
</tr>
</tbody>
</table>

**Note**

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

Cisco Remote PHY Controller Profile and RPD Configuration

• Cisco Remote PHY Controller Profile and RPD Configuration, on page 51
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/. You do not require a cisco.com login account.

- Hardware Compatibility Matrix for Cisco Remote PHY Device, on page 52
- Controller Profile and RPD, on page 52
- Configure Controller Profile and RPD, on page 54
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>
<thead>
<tr>
<th>Cisco HFC Platform</th>
<th>Remote PHY Device</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cisco GS7000 Super High Output Node</strong></td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2=</td>
</tr>
<tr>
<td></td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2-PKEY=</td>
</tr>
<tr>
<td><strong>Cisco GS7000 Super High Output Intelligent Node (iNode)</strong></td>
<td>and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Intelligent Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—iRPD-1X2=</td>
</tr>
<tr>
<td></td>
<td>• PID—iRPD-1X2-PKEY=</td>
</tr>
</tbody>
</table>

**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.

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

**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**

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
```
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
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, *15:36:49.778 UTC Thu Mar 8 2018

RDP ID: badb.ad13.417c

<table>
<thead>
<tr>
<th>Interface</th>
<th>Total Reg Oper</th>
<th>Unreg Offline</th>
<th>Wideband initRC</th>
<th>initID initIO</th>
<th>initD</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C9/0/4/U0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>badb.ad13.417c us</td>
</tr>
<tr>
<td>C9/0/4/U1</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>badb.ad13.417c us</td>
</tr>
<tr>
<td>C9/0/4/U3</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>badb.ad13.417c us</td>
</tr>
<tr>
<td>C9/0/5/U0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>badb.ad13.417c us</td>
</tr>
<tr>
<td>C9/0/5/U1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>badb.ad13.417c us</td>
</tr>
</tbody>
</table>
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
```
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 2, 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:

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

### Configure Downstream Sharing

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

```bash
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

MAC Address    IP Address   I/F    MAC 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 Related 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
### 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**

<table>
<thead>
<tr>
<th>Total tunnels</th>
<th>Total sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26</td>
</tr>
</tbody>
</table>

**LocTunID** | **RemTunID** | **Remote Device** | **State** | **Remote Address** | **Sessn L2TP Class** | **Count** | **Last Chg** | **Uniq ID** | **Type** | **Mode** | **RemSt** |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>338514820</td>
<td>671581873</td>
<td>0004.9f00.0901</td>
<td>est</td>
<td>10.10.10.11</td>
<td>rphy-l2tp-gl...</td>
<td>26</td>
<td>00:34:57</td>
<td>21</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
</tbody>
</table>

**LocID** | **RemID** | **Pseudowire** | **State** | **Last Chg** | **Uniq ID** | **Type** | **Mode** | **RemSt** |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0x410400000</td>
<td>0x000000B00</td>
<td>US1/0/0/0:2(R)</td>
<td>est</td>
<td>00:34:57</td>
<td>21</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
<tr>
<td>0x410100000</td>
<td>0x000006000</td>
<td>US1/0/0:0(D)</td>
<td>est</td>
<td>00:34:57</td>
<td>11</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
<tr>
<td>0x000002006</td>
<td>0x000004005</td>
<td>DS1/0/0:5</td>
<td>est</td>
<td>00:34:57</td>
<td>6</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
<tr>
<td>0x000002004</td>
<td>0x000004003</td>
<td>DS1/0/0:3</td>
<td>est</td>
<td>00:34:57</td>
<td>4</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
<tr>
<td>0x41000000C</td>
<td>0x000000003</td>
<td>US1/0/0:3(M)</td>
<td>est</td>
<td>00:34:57</td>
<td>23</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
<tr>
<td>0x000002002</td>
<td>0x000004001</td>
<td>DS1/0/0:1</td>
<td>est</td>
<td>00:34:57</td>
<td>2</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
<tr>
<td>0x000002007</td>
<td>0x000004006</td>
<td>DS1/0/0:6</td>
<td>est</td>
<td>00:34:57</td>
<td>7</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
<tr>
<td>0x000002008</td>
<td>0x000004007</td>
<td>DS1/0/0:7</td>
<td>est</td>
<td>00:34:57</td>
<td>8</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
<tr>
<td>0x41010000C</td>
<td>0x000006003</td>
<td>US1/0/0:3(D)</td>
<td>est</td>
<td>00:34:57</td>
<td>24</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
<tr>
<td>0x410000004</td>
<td>0x000006001</td>
<td>US1/0/0:1(M)</td>
<td>est</td>
<td>00:34:57</td>
<td>15</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
<tr>
<td>0x000002001</td>
<td>0x000004000</td>
<td>DS1/0/0:0</td>
<td>est</td>
<td>00:34:57</td>
<td>1</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
<tr>
<td>0x410800009</td>
<td>0x000002002</td>
<td>US1/0/0:2(S)</td>
<td>est</td>
<td>00:34:57</td>
<td>22</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
<tr>
<td>0x410100004</td>
<td>0x000006001</td>
<td>US1/0/0:1(D)</td>
<td>est</td>
<td>00:34:57</td>
<td>16</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
<tr>
<td>0x410200000</td>
<td>0x000008000</td>
<td>US1/0/0:0(B)</td>
<td>est</td>
<td>00:34:57</td>
<td>12</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
<tr>
<td>0x000002009</td>
<td>0x000004008</td>
<td>DS1/0/0:8</td>
<td>est</td>
<td>00:34:57</td>
<td>9</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
<tr>
<td>0x410100008</td>
<td>0x000006002</td>
<td>US1/0/0:2(D)</td>
<td>est</td>
<td>00:34:57</td>
<td>20</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
<tr>
<td>0x410000008</td>
<td>0x000006002</td>
<td>US1/0/0:2(M)</td>
<td>est</td>
<td>00:34:57</td>
<td>19</td>
<td>P</td>
<td>PSP</td>
<td>UP</td>
</tr>
</tbody>
</table>
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 16: show cable rpd depi Field Descriptions

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

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 5000000
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
```
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.

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>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Scale Controller Support (32DS/64US) with node</td>
<td>Cisco 1x2 RPD Software 1.1</td>
<td>This feature was introduced on the Cisco Remote PHY Device.</td>
</tr>
<tr>
<td>256 RPD Support per Chassis</td>
<td>Cisco 1x2 RPD Software 1.1</td>
<td>This feature was introduced on the Cisco Remote PHY Device.</td>
</tr>
<tr>
<td>Controller profile configuration</td>
<td>Cisco 1x2 RPD Software 1.1</td>
<td>This feature was introduced on the Cisco Remote PHY Device.</td>
</tr>
<tr>
<td>US 128 channels</td>
<td>Cisco 1x2 RPD Software 1.1</td>
<td>This feature was introduced on the Cisco Remote PHY Device.</td>
</tr>
</tbody>
</table>
PART V

Cisco Remote PHY Device Downstream Virtual Splitting

• Cisco Remote PHY Device Downstream Virtual Splitting, on page 67
CHAPTER 10

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/. You do not require a cisco.com login account.

• Hardware Compatibility Matrix for Cisco Remote PHY Device, on page 67
• Information about RPD Downstream Virtual Splitting, on page 68
• Configure RPD Downstream Virtual Splitting, on page 68
• Example: RPD Downstream Virtual Splitting Configuration, on page 73
• Feature Information for RPD Downstream Virtual Splitting, on page 75

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**

<table>
<thead>
<tr>
<th>Cisco HFC Platform</th>
<th>Remote PHY Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco GS7000 Super High Output Node</td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2=</td>
</tr>
<tr>
<td></td>
<td>Cisco GS7000 Super High Output Intelligent Node (iNode)</td>
</tr>
<tr>
<td></td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2-PKEY=</td>
</tr>
</tbody>
</table>

**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
```

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:
RDP 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
```
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
```
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 Da3/0/0:0 est 04:20:36 1 P
  0x40003F31 0x80003D32 1377638051 Da3/0/0:16 est 04:20:35 3 P
  0x40003F41 0x80003D42 1377638051 Da3/0/0:32 est 04:20:35 5 P
  0x40003F39 0x80003D3A 1377638051 Da3/0/0:24 est 04:20:35 4 P
  0x40103F21 0x80003D22 1404837649 Da3/0/0:0 est 04:20:34 2 P
  0x40103F39 0x80003D3A 1404837649 Da3/0/0:24 est 04:20:34 14 P
  0x40103F41 0x80003D42 1404837649 Da3/0/0:32 est 04:20:34 17 P
  0x40103F29 0x80003D2A 1404837649 Da3/0/0:8 est 04:20:34 15 P
  0x40103F39 0x80003D3A 1404837649 Da3/0/0:24 est 04:20:34 17 P
  0x40103F39 0x80003D39 1404837649 Da3/0/0:32 est 04:20:34 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 depi
  Load for five secs: 8%/3%; one minute: 9%; five minutes: 9%
  No time source, *16:06:52.191 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
  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
  ```
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 DEP! 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)# multicarrier 128
Router(config-controller-profile)# base-channel-power 34
Router(config-controller-profile)# rf-chan 0 95
Router(config-controller-profile)# type DOCSIS
Router(config-controller-profile)# frequency 285000000
Router(config-controller-profile)# rf-output NORMAL
Router(config-controller-profile)# qam-profile 1
Router(config-controller-profile)# power-adjust 0
Router(config-controller-profile)# docsis-channel-id 1
Router(config)# end
```

Cisco Remote PHY Device Downstream Virtual Splitting
Example: RPD Downstream Virtual Splitting Configuration

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)# 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 800000F0
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
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 19: Feature Information for RPD Downstream Virtual Splitting

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS virtual splitting</td>
<td>Cisco 1x2 RPD Software 1.1</td>
<td>This feature was introduced on the Cisco eBR Series Converged Broadband Routers.</td>
</tr>
</tbody>
</table>
PART VI

Cisco Remote PHY Video Configuration

• Cisco Remote PHY Video Configuration, on page 79
CHAPTER 11

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/. You do not require a cisco.com login account.

- Hardware Compatibility Matrix for Cisco Remote PHY Device, on page 79
- Hardware Compatibility Matrix for Cisco Remote PHY Device, on page 80
- Information About R-PHY Video Configuration, on page 81
- How to Configure R-PHY Video, on page 81
- Example: R-PHY Video Configuration, on page 83
- Feature Information for Remote PHY Video, on page 85

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

<table>
<thead>
<tr>
<th>Cisco HFC Platform</th>
<th>Remote PHY Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco GS7000 Super High Output Node</td>
<td><strong>Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases</strong></td>
</tr>
<tr>
<td></td>
<td>* PID—RPD-1X2=</td>
</tr>
<tr>
<td></td>
<td><strong>Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases</strong></td>
</tr>
<tr>
<td></td>
<td>* PID—RPD-1X2-PKEY=</td>
</tr>
<tr>
<td></td>
<td><strong>Cisco Remote PHY Device 1x2</strong></td>
</tr>
<tr>
<td></td>
<td>* PID—RPD-1X2=</td>
</tr>
<tr>
<td></td>
<td><strong>Cisco GS7000 Super High Output Intelligent Node (iNode)</strong></td>
</tr>
<tr>
<td></td>
<td>* PID—iRPD-1X2=</td>
</tr>
<tr>
<td></td>
<td>* PID—iRPD-1X2-PKEY=</td>
</tr>
<tr>
<td></td>
<td><strong>Cisco Intelligent Remote PHY Device 1x2</strong></td>
</tr>
<tr>
<td></td>
<td>* PID—iRPD-1X2=</td>
</tr>
</tbody>
</table>

**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 21: Hardware Compatibility Matrix for the Cisco Remote PHY Device

<table>
<thead>
<tr>
<th>Cisco HFC Platform</th>
<th>Remote PHY Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco GS7000 Super High Output Node</td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2=</td>
</tr>
<tr>
<td></td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2-PKEY=</td>
</tr>
<tr>
<td>Cisco GS7000 Super High Output Intelligent Node (iNode)</td>
<td>and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Intelligent Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—iRPD-1X2=</td>
</tr>
<tr>
<td></td>
<td>• PID—iRPD-1X2-PKEY=</td>
</tr>
</tbody>
</table>

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 downstream 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-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
Router(config-profile)# exit
Router(config)# 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
Router(config-profile)# exit

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
• 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)# 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)# 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

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.

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
Example: R-PHY Video Configuration

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-ds 0 downstream-cable 6/0/1 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-core)# r-dti 3
Router(config-rpd-core)# rpd-event profile 0
Router(config-rpd-core)# 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
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 22: Feature Information for Remote PHY Video

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPHY Video PME VOD</td>
<td>Cisco 1x2 RPD Software 1.1</td>
<td>This feature was introduced on the Cisco Remote PHY Device.</td>
</tr>
<tr>
<td>RPHY Video Pre-Encrypted MPTS Pass-Thru Support</td>
<td>Cisco 1x2 RPD Software 1.1</td>
<td>This feature was introduced on the Cisco Remote PHY Device.</td>
</tr>
<tr>
<td>RPHY Pre-encrypted Broadcast Video Support</td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1</td>
<td>This support was introduced on the Cisco Remote PHY Device 1x2.</td>
</tr>
</tbody>
</table>
PART VII

Cisco Remote PHY Out of Band

- Cisco Remote PHY Out of Band, on page 89
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/. You do not require a cisco.com login account.

- Hardware Compatibility Matrix for Cisco Remote PHY Device, on page 89
- Information About Out of Band, on page 90
- How to Configure 55-1 OOB, on page 90
- Example: OOB Configuration, on page 91
- Feature Information for OOB, on page 92

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 23: Hardware Compatibility Matrix for the Cisco Remote PHY Device

<table>
<thead>
<tr>
<th>Cisco HFC Platform</th>
<th>Remote PHY Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco GS7000 Super High Output Node</td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2=</td>
</tr>
<tr>
<td></td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2-PKEY=</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cisco GS7000 Super High Output Intelligent Node (iNode)</th>
<th>and Later Releases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cisco Intelligent Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—iRPD-1X2=</td>
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<tr>
<td></td>
<td>• PID—iRPD-1X2-PKEY=</td>
</tr>
</tbody>
</table>

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.

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:

```bash
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

**Configuring Profile for 55-1 OOB**

To configure profile to use OOB, complete the following procedure:

```conf
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:

```conf
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
```

**Example: OOB Configuration**

The following example shows how to configure OOB:

```none
Router#configure terminal
Router(config)# cable oob
```
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 24: Feature Information for OOB

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out of Band</td>
<td>Cisco 1x2 RPD Software 1.1</td>
<td>This feature was introduced on the Cisco Remote PHY Device.</td>
</tr>
<tr>
<td>Support for OOB 55-2</td>
<td>Cisco 1x2 / Compact Shelf RPD</td>
<td>This feature was introduced on the Cisco Remote PHY Device 1x2.</td>
</tr>
<tr>
<td></td>
<td>Software 2.1</td>
<td></td>
</tr>
</tbody>
</table>
PART VIII

Cisco Remote PHY Line Card and Supervisor Redundancy

• Cisco Remote PHY Line Card and Supervisor Redundancy, on page 97
CHAPTER 13

Cisco Remote PHY Line Card and Supervisor Redundancy

• Hardware Compatibility Matrix for Cisco Remote PHY Device, on page 97
• Information About Remote PHY Line Card and Supervisor Redundancy, on page 98
• How to Configure Remote PHY Line Card Redundancy, on page 100
• Feature Information for Remote PHY Line Card and Supervisor Redundancy, on page 101

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

<table>
<thead>
<tr>
<th>Cisco HFC Platform</th>
<th>Remote PHY Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco GS7000 Super High Output Node</td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2=</td>
</tr>
<tr>
<td></td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2-PKEY=</td>
</tr>
</tbody>
</table>
### 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 4: 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 5: 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 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
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 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 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 init(l2tp) Pri Act 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
```
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

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)# principal
Router(config-rpd-core)# rpd-ds 0 downstream-cable 8/1/0 profile 0
Router(config-rpd-core)# rpd-ds 0 downstream-cable 8/1/0 profile 0
Router(config-rpd-core)# exit

Router(config)# cable rpd node2
Router(config-rpd)# identifier 0004.9f03.0163
Router(config-rpd-core)# principal
```

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.
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

<table>
<thead>
<tr>
<th>Slot</th>
<th>Subslot</th>
<th>LC</th>
<th>My</th>
<th>Peer</th>
<th>Peer</th>
<th>Peer</th>
<th>State</th>
<th>State</th>
<th>Slot</th>
<th>Subslot</th>
<th>Role</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 0</td>
<td></td>
<td>Active</td>
<td>Stdby</td>
<td>Warm</td>
<td>6</td>
<td>-</td>
<td>Primary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 0</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Multiple</td>
<td>None</td>
<td>Standby</td>
<td>Secondary</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Router# show cable rpd lcha-cores

<table>
<thead>
<tr>
<th>MAC Address</th>
<th>IP Address</th>
<th>I/F</th>
<th>State</th>
<th>Core Role</th>
<th>HA Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>0004.9f03.0055</td>
<td>80.6.16.15</td>
<td>Te6/1/0</td>
<td>online</td>
<td>Principal</td>
<td>Standby</td>
</tr>
<tr>
<td>0004.9f03.0055</td>
<td>80.6.16.15</td>
<td>Te8/1/0</td>
<td>online</td>
<td>Principal</td>
<td>Active</td>
</tr>
<tr>
<td>0004.9f03.0163</td>
<td>80.6.16.16</td>
<td>Te6/1/1</td>
<td>online</td>
<td>Principal</td>
<td>Standby</td>
</tr>
<tr>
<td>0004.9f03.0163</td>
<td>80.6.16.16</td>
<td>Te8/1/1</td>
<td>online</td>
<td>Principal</td>
<td>Active</td>
</tr>
</tbody>
</table>

Router# show cable rpd

<table>
<thead>
<tr>
<th>MAC Address</th>
<th>IP Address</th>
<th>I/F</th>
<th>State</th>
<th>Core Role</th>
<th>HA Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>0004.9f03.0055</td>
<td>80.6.16.15</td>
<td>Te6/1/0</td>
<td>online</td>
<td>Principal</td>
<td>Active</td>
</tr>
<tr>
<td>0004.9f03.0163</td>
<td>80.6.16.16</td>
<td>Te6/1/1</td>
<td>online</td>
<td>Principal</td>
<td>Active</td>
</tr>
</tbody>
</table>

Feature Information for Remote PHY Line Card and Supervisor 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 26: Feature Information for Remote PHY Line Card and Supervisor Redundancy

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote PHY LCHA</td>
<td>Cisco 1x2 RPD Software 1.1</td>
<td>This feature was introduced on the Cisco Remote PHY Device.</td>
</tr>
</tbody>
</table>
### Feature Information for Remote PHY Line Card and Supervisor Redundancy

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote PHY SUPHA</td>
<td>Cisco 1x2 RPD Software 1.1</td>
<td>This feature was introduced on the Cisco Remote PHY Device.</td>
</tr>
</tbody>
</table>
PART IX

Cisco Remote PHY Management

- Secure Software Download, on page 105
- Cisco Remote PHY Fault Management, on page 109
- Cisco Remote PHY Device Operations and Debugging, on page 113
CHAPTER 14

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, on page 105
- Information About Secure Software Download, on page 106
- How to Upgrade Software from RPD and Cisco cBR Using SSD, on page 106
- Examples for Upgrading RPD Software Using SSD, on page 108
- Feature Information for Secure Software Download, on page 108

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

<table>
<thead>
<tr>
<th>Cisco HFC Platform</th>
<th>Remote PHY Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco GS7000 Super High Output Node</td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2=</td>
</tr>
<tr>
<td></td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2-PKEY=</td>
</tr>
</tbody>
</table>
### Cisco HFC Platform

<table>
<thead>
<tr>
<th>Cisco GS7000 Super High Output Intelligent Node (iNode)</th>
<th>Remote PHY Device and Later Releases</th>
</tr>
</thead>
</table>

- 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

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
Examples for Upgrading RPD Software Using SSD

This section provides example for the Software Using SSD configuration.

Example: RPD Software Upgrade Using SSD on Cisco cBR

cable rpd 0004.9f00.0861 ssd 20.1.0.33
tftp userid/RPD_seres_rpd_20170218_010001.itb.SSA
rpd 0004.9f00.0861 server:20.1.0.33, proto:TFTP,
file:userid/RPD_seres_rpd_20170218_010001.itb.SSA

Example: RPD Software Upgrade Using SSD on RPD

RPHY#ssd set server 10.79.41.148
filename RPD_seres_rpd_20170103_010002.itb.SSA transport tftp
Router#ssd control start

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.

Table 28: Feature Information for Secure Software Download

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secure Software Download</td>
<td>Cisco 1x2 RPD Software 1.1</td>
<td>This feature was introduced on the Cisco Remote PHY Device.</td>
</tr>
</tbody>
</table>
CHAPTER 15

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, on page 109
- How to Configure RPD Events, on page 110
- Configuration Examples, on page 111
- Feature Information for R-PHY Fault Management, on page 112

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

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
```

If RPD is online when changing the profile, reset the RPD, after you change the profile.

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

<table>
<thead>
<tr>
<th>RPD</th>
<th>EventId</th>
<th>Level</th>
<th>Count</th>
<th>LastTime</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>0004.9f00.0861 66070204</td>
<td>Error</td>
<td>1</td>
<td>Feb 21 12:11:06</td>
<td>GCP Connection Failure</td>
<td></td>
</tr>
<tr>
<td>0004.9f00.0861 2148074241</td>
<td>Error</td>
<td>1</td>
<td>Feb 21 12:11:25</td>
<td>Session failed: connecting timeout, @SLAVE: 93.3.50.7:None --&gt; 30.85.33.2:8190; RPD-ID=0004.9f00.0861;</td>
<td></td>
</tr>
</tbody>
</table>

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
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
```
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.

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>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-PHY Fault Management</td>
<td>Cisco 1x2 RPD Software 1.1</td>
<td>This feature was introduced on the Cisco Remote PHY Device.</td>
</tr>
</tbody>
</table>
CHAPTER 16

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, on page 113
- Information about RPD Operations and Debugging, on page 114
- How to Access and Debug RPD, on page 114
- Configuration Examples, on page 116
- Feature Information for RPD Operations and Debugging, on page 117

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 30: Hardware Compatibility Matrix for the Cisco Remote PHY Device

<table>
<thead>
<tr>
<th>Cisco HFC Platform</th>
<th>Remote PHY Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco GS7000 Super High Output Node</td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2=</td>
</tr>
<tr>
<td></td>
<td>Cisco 1x2 / Compact Shelf RPD Software 2.1a and Later Releases</td>
</tr>
<tr>
<td></td>
<td>Cisco Remote PHY Device 1x2</td>
</tr>
<tr>
<td></td>
<td>• PID—RPD-1X2-PKEY=</td>
</tr>
</tbody>
</table>
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

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.
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)`
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.

```bash
R-PHY#show ssh session
connected session: 1
ssh password auth: off
ssh NMS pubkey num: 1
R-PHY#
```

Configuration Examples

This section provides examples for the fault management configuration on R-PHY.

**Example: Generating a New NMS pubkey**

```bash
$ cat ~/.ssh/id_rsa.pub

$ ssh-keygen -t rsa

$ cat ~/.ssh/id_rsa.pub

ssh-rsa AAAAB3NzaC1yc2EAAAABIwAAAgEAtQCXVFmRIwemejbTx0+U8taMq5n4Zetu 71xb+dtH8vRs0wejjIK1YJK93n9hcBxsjHRu766lP991+DDNL3+THljwnMQC1cadvRmgXoe GfimT9aT1GD/ RW92ywYt8Kep9VnANu2DWSoh0wq2pE49HFOJAbGfuFOvFEdwZGDMQNWs Eq/3xAQjBxajQqfgu41tgVzKoo4PM/xx9X4Z1aMwxS3DvyvN7L80033mcDNasal3Si1jMSSNfq YpwoFUQVe8c2onrYHUx2p3BWOBb/0FzFQhZM8BTxM/pDMXq/fkkD0uguk1xOGngAATMjsSHlN 0U0dvbzhhrmFRBBM4NZqQG5kNC7RvnWgxIE7HdalERvMyBC2MCgDFSHmQFYWmHEHFpMlIXK9NW XautoR6fzzs+4hingE49DFHWNwT6W0rjuKq61U= userid@example.cisco.com
```

**Example: Adding NMS pubkey in RPD**

```bash
R-PHY#conf t
R-PHY(config)#ssh pubkey add ?
LINE NMS's pubkey
R-PHY(config)#ssh pubkey add ssh-rsa AAAAB3NzaC1yc2E876bhjdsk EEEAAAB1wAAAgEz3nFp0v0k3Nf4UvSTuOQQi2h0mAfAtQCXVFmRIwemejbTx0+U8taM
```
Feature Information for RPD Operations and Debugging

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### Table 31: Feature Information for RPD Operations and Debugging

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<th>Releases</th>
<th>Feature Information</th>
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</thead>
<tbody>
<tr>
<td>RPD Operations and Debugging</td>
<td>Cisco 1x2 RPD Software 1.1</td>
<td>This feature was introduced on the Cisco Remote PHY Device.</td>
</tr>
</tbody>
</table>