Narrowband Digital Forward And Narrowband Digital Return

This document describes the narrowband digital forward and narrowband digital return feature.

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Hardware Compatibility Matrix for the Cisco cBR Series Routers

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

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

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

Note Do not use DPICs (8X10G and 2x100G) to forward IP traffic, as it may cause buffer exhaustion, leading to line card reload.

The only allowed traffic on a DPIC interface is DEPI, UEPI, and GCP traffic from the Cisco cBR-8 router to Remote PHY devices. Other traffic such as DHCP, SSH, and UTSC should flow via another router, since DPICs cannot be used for normal routing.

Information About NDF and NDR

Narrowband Digital Forward (NDF) refers to the digitizing of an analog portion of the downstream spectrum at the headend, sending the digital samples as payload in [DEPI] packets to the RPD, and then re-creating the original analog stream at the RPD. NDF supports services such as FM Broadcast, DAB+ Broadcast, and OOB signals for Forward Sweep, DS Leakage, and Element management.

Narrowband Digital Return (NDR) refers to the digitizing of an analog portion of the upstream spectrum at the RPD, sending the digital samples as payload in [R-UEPI] packets to the CMTS, and then re-creating the original analog stream at the headend. NDR supports legacy OOB signals for Reverse Sweep, Return Path Monitoring, FSK based HMS, and other FSK based telemetry signals.

Restrictions for Configuring NDF and NDR

The following restrictions are applicable for configuring NDF and NDR:

1x2 RPD

NDF

- Supports a maximum of three narrow band NDF channels if OOB 55-1 or OOB 55-2 is not configured. Only channel ID 0, 1 and 2 can be used for 1x2 RPD, channel ID 3 is not supported and will be rejected by 1x2 RPD.
- If OOB 55-1 DS is configured, only one NDF channel is supported. OOB 55-1 DS uses first and the second OOB channel while NDF uses the third OOB channel. If 55-1 DS is configured after configuring NDF, ensure that not more than one NDF channel is configured.
- If OOB 55-2 is configured, two NDF channels are supported. OOB 55-2 uses the first OOB channel.
- Supports NDF Mode 0 to Mode 6. NDF Mode 7 is not supported.

NDR

- Each upstream port supports three OOB channels. OOB 55-1 and OOB 55-2 channels share the upstream OOB resource with NDR channels.
- If two OOB 55-1 channels are configured on upstream port 0, then only one NDR channel is supported on port 0, and up to three NDR channels are suppported on port 1.
- If one OOB 55-2 upstream channel is configured on a port, then either one mode 6 (5.12 MHz) NDR can be configured or 2 NDR with mode 5 or lesser can be configured.
- NDR Mode 0 (80 KHz) is not supported.

2x2 RPD

Starting from Cisco IOS XE Amsterdam 17.2.1, 4 NDF (3 narrowband and 1 wideband) sessions are supported.

Configure NDF and NDR

To configure NDF and NDR, perform these steps.

1. Configure static-pseudowires for NDF and NDR.
2. Configure NDF and NDR profiles.
3. Bind static-pseudowires and profiles with RPD.

Configure Static-Pseudowires for NDF and NDR

Note

- For NDF static pseudowire, session ID must be unique within a rf-port across all rf-channels configured in that port.
- For NDR static pseudowire, the session ID and the server IP must be unique within a RPD.

To configure NDF static-pseudowires, run the following commands:

```
Router# enable
Router# configure terminal
Router(config)# cable oob
Router(config-oob)# [no] static-pseudowire <name> type ndf [id <id>]
Router(config-oob-spw)# [no] dest-ip <ipv4/ipv6 addr> [source-ip <ipv4 | ipv6 addr>]
Router(config-oob-spw)# [no] session-id <session id>
```

To configure NDR static-pseudowires, run the following commands:

```
Router# enable
Router# configure terminal
Router(config)# cable oob
Router(config-oob)# [no] static-pseudowire <name> type ndr [id <id>]
Router(config-oob-spw)# [no] server-ip <ipv4/ipv6 addr>
Router(config-oob-spw)# [no] mtusize <mtu size value>
Router(config-oob-spw)# [no] per-hop-behavior <IP DSCP per hop behavior value>
Router(config-oob-spw)# [no] session-id <session id>
```

Table 2: Syntax Description

Syntax	Description
name	Specify a unique name for the static-pseudowire. The name can be up to 30 characters long and is case sensitive.The name can be alphanumeric and undescore (_) can be used.
id	Specify a unique ID for the static-pseudowire. The valid range is from 1 to 4294967295. If the ID is not specified, the system auto-generates an ID.

Syntax	Description
dest-ip	For multicast NDF, specify the Group (Destination) IP address of the multicast group from which RPD has to receive data on a static pseudowire. For unicast NDF, the Group (Destination) IP address is set to 0.0.0.0 or 0::0. The Group (Destination) IP address can IPv4 or IPv6.
source-ip	For source specific multicast (SSM) group, specify the source IP address of the multicast group that RPD has to join to to receive data on a static pseudowire. For unicast NDF, specify the source IP address of the remote peer from which RPD has to receive data on a NDF static pseudowire.
server-ip	Specify the destination IP address from which RPD has to receive data on a static pseudowire. The server IP can be IPv4 or IPv6 address.
type	Configure the static-pseudowire type. The static-pseudowire type is NDF or NDR.
mtusize	Specify the MTU (Maximum Transmission Unit) size supported by the CCAP Core on a return static pseudowire. MTU is the Layer 3 payload of a Layer 2 frame. The MtuSize attribute carries information equivalent to DEPI Local MTU. CCAP core can receive the configured MTU size from the RPD on the CIN interface. The valid range for MTU size is 1500–9216. The default MTU size is 1500.

Syntax	Description
per-hop-behavior	Specify the Per Hop Behavior Identifier that is equal to the 6-bit DSCP with which the RPD transmits L2TPv3 data packets on the selected return static pseudowire.The per-hop-behavior configures information that is equivalent to the information configured by the PHBID field of the Upstream Flow. The upper two bits are set as 00 by the CCAP core and ignored by the RPD. The default value is 0. These standard QOS DSCP values are allowed to be selected in the CLI. af11 Match packets with AF11 dscp (001010) af12 Match packets with AF12 dscp (001100) af13 Match packets with AF13 dscp (001110) af21 Match packets with AF21 dscp (010010) af22 Match packets with AF22 dscp (010100) af23 Match packets with AF23 dscp (010110) af31 Match packets with AF31 dscp (011010) af32 Match packets with AF32 dscp (011100) af33 Match packets with AF33 dscp (011110) af41 Match packets with AF41 dscp (100010) af42 Match packets with AF42 dscp (100100) af43 Match packets with AF43 dscp (100110) cs1 Match packets with CS1(precedence 1) dscp (001000) cs2 Match packets with CS2(precedence 2) dscp (010000) cs3 Match packets with CS3(precedence 3) dscp (011000) cs4 Match packets with CS4(precedence 4) dscp (100000) cs5 Match packets with CS5(precedence 5) dscp (101000) cs6 Match packets with CS6(precedence 6) dscp (110000) cs7 Match packets with CS7(precedence 7) dscp (111000) default Match packets with default dscp (000000) ef Match packets with EF dscp (101110)
session-id	Configure the session ID for the static pseudowire. **Note** One session ID is configured for each static pseudowire as static pseudowires are defined in a single direction.

Configure NDF and NDR Profile

Note You can configure only one rf-channel in a NDF and NDR profile.

To configure NDF profile, run the following commands:

```
Router# enable
Router# configure terminal
Router(config)# [no] controller downstream-oob NDF-profile <profile id>
Router(config-profile)# [no] ds-channel <channel id> rf-mute
Router(config-profile)# [no] ds-channel <channel id> shutdown
Router(config-profile)# [no] ds-channel <channel id> frequency <frequency>
Router(config-profile)# [no] ds-channel <channel id> width <width>
Router(config-profile)# [no] ds-channel <channel id> poweradjust <power-adjust>
```

To configure NDR profile, run the following commands:

```
Router# enable
Router# configure terminal
Router(config)# [no] controller upstream-oob NDR-profile <profile id>
Router(config-profile)# [no] us-channel <channel id> shutdown
Router(config-profile)# [no] us-channel <channel id> frequency <frequency>
Router(config-profile)# [no] us-channel <channel id> width <width>
Router(config-profile)# [no] us-channel <channel id> poweradjust <power-adjust>
```

Table 3: Syntax Description

Syntax	Description
rf-mute	Specify True to set the modulator in the muted diagnostic state. In the muted diagnostic state, the modulator does not transmit signal, but the operational status of the channel is not affected.
shutdown	Set the administrative state of the selected NDF/NDR channel. Specifying shutdown removes all configuration from the channel. Specifying unshutdown retrieves all configuration of the channel.
width	Sepcify the total width of the spectrum in Hertz, including any required guardband.
frequency	Specify the frequency of the channel in Hertz.
poweradjust	Specify the power level adjustment for the NDF channel relative to the base power level configured for the DS RF port.

Bind NDF Static-Pseudowire and NDF Profile with Rf-Port

Note

- Destination IP address must be configured before binding NDF static-pseudowire to RPD. Once the destination IP address is bound, it cannot be removed, but can be updated.
- Frequency and channel width must be configured in NDF profile before binding NDF static-pseudowire to RPD. If frequency is configured, channel width cannot be removed or updated. To remove or update the channel width from the NDF profile, you must remove the frequency.
- To update frequency and channel width when the NDF profile is associated with the RPD, you must shut down the rf-channel in the NDF profile.

To bind NDF static-pseudowire and NDF profile with rf-port, execute the bind commands under **core-interface TenGigabitEthernet [interface]** command:

```
Router# configure terminal
Router(config)# cable rpd <rpd name>
Router(config-rpd)# core-interface TenGigabitEthernet <interface>
Router(cable-rpd-core)# [no] rpd-ds <port id> static-pseudowire <name> profile <id>
```

Bind NDR Static-Pseudowire and NDR Profile with Rf-Port

Note

- Server IP address must be configured before binding NDR static-pseudowire to RPD. Once the server IP address is bound, it cannot be removed, but can be updated.
- Frequency and channel width must be configured in NDR profile before binding NDR static-pseudowire to RPD. If frequency is configured, channel width cannot be removed or updated. To remove or update the channel width from the NDR profile, you must remove the frequency.
- To update frequency and channel width when the NDR profile is associated with the RPD, you must shut down the rf-channel in the NDR profile.

To bind NDR static-pseudowire and NDR profile with rf-port, run the bind commands under **core-interface TenGigabitEthernet [interface]** command.

```
Router# configure terminal
Router(config)# cable rpd <rpd name>
Router(config-rpd)# core-interface TenGigabitEthernet <interface>
Router(cable-rpd-core)# [no] rpd-us <port id> static-pseudowire <name> profile <id>
```

Display TLV Status

To display the TLV status sent from cBR-8, run these commands:

Router# show cable rpd ndf-channels

Router# show cable rpd ndr-channels

To display per channel static-pseudowire and controller profile configuration, run these commands:

Router# show cable rpd ndf-channels detailed

Router# show cable rpd ndr-channels detailed

These examples show how to display the TLV status.

```
Router# show cable rpd ndf-channels
RPD-MAC-ID      Port  Chan Session-Id  AdminState   Rf-Mute  Frequency TLV-94-Status
0004.9f31.0785  0     0    0x88000001  NO SHUTDOWN  NO MUTE  70000000  Failed-In-RPD
0004.9f31.0785  0     1    0x88000002  NO SHUTDOWN  NO MUTE  72000000  RPD-Not-Capable
0004.9f31.0785  0     2    0x88000003  NO SHUTDOWN  NO MUTE  74000000  RPD-Not-Capable
0004.9f31.0785  1     0    0x88000001  NO SHUTDOWN  NO MUTE  70000000  RPD-Not-Capable
0004.9f31.0785  1     1    0x88000002  NO SHUTDOWN  NO MUTE  72000000  RPD-Not-Capable
0004.9f31.0785  1     2    0x88000003  NO SHUTDOWN  NO MUTE  74000000  RPD-Not-Capable

TLV-58-Status   RPD-NAME
Success-In-RPD  RPD0-RACK1
RPD-Not-Capable RPD0-RACK1
RPD-Not-Capable RPD0-RACK1
RPD-Not-Capable RPD0-RACK1
RPD-Not-Capable RPD0-RACK1
RPD-Not-Capable RPD0-RACK1

Router# show cable rpd ndr-channels
RPD-MAC-ID     Port Chan  Session-Id  AdminState   Frequency  TLV-95-Status
0004.9f31.0785  0   0     0x48000001  NO SHUTDOWN  5216000    Failed-In-RPD
0004.9f31.0785  0   1     0x48000002  NO SHUTDOWN  5216000    RPD-Not-Capable
0004.9f31.0785  0   2     0x48000003  NO SHUTDOWN  5416000    RPD-Not-Capable
0004.9f31.0785  1   0     0x48000001  NO SHUTDOWN  5216000    Failed-In-RPD
0004.9f31.0785  1   1     0x48000002  NO SHUTDOWN  5216000    RPD-Not-Capable
0004.9f31.0785  1   2     0x48000003  NO SHUTDOWN  5416000    RPD-Not-Capable


TLV-58-Status   RPD-NAME
Success-In-RPD  RPD0-RACK1
RPD-Not-Capable RPD0-RACK1
RPD-Not-Capable RPD0-RACK1
Success-In-RPD  RPD0-RACK1
RPD-Not-Capable RPD0-RACK1
RPD-Not-Capable RPD0-RACK1
```

Table 4: TLV Status Description

TLV Status	Description
Success-In-RPD	NDF/NDR configuration is sent to the RPD and RPD sends the response TLV with status as SUCCESS.
Failed-In-RPD	NDF/NDR configuration is sent to the RPD and RPD sends the response TLV with status as ERROR.
Sent-To-RPD	NDF/NDR configuration is sent to the RPD but no reponse is recieved from the RPD.
Failed-To-Send	NDF/NDR TLV fails to deliver from CCAP core to RPD.
RPD-Not-Capable	RPD is not capable of supporting attributes in TLV. For example, if RPD does not support NDF or NDR, the TLV status sent as RPD-Not-Capable.

TLV Status	Description
In-Progress	Frequency and channel width are set to 0 in a NDF or NDR profile. Depending on the TLV response from the RPD when frequency and channel width are configured and a no shutdown is performed on the rf-channel, the In-Progress status changes.
RPD-Offline	RPD is offline.

Example: NDF Configuration

This example shows how to configure static-pseudowire for NDF.

Configure static-pseudowire for unicast NDF

```
Router# configure terminal
Router(config)# cable oob
Router(config-oob)# static-pseudowire ndf0 type ndf id 1
Router(config-oob-spw)# dest-ip 0.0.0.0 source-ip 192.168.1.10
Router(config-oob-spw)# session-id 0x1
```

Configure static-pseudowire for multicast NDF

```
Router# configure terminal
Router(config)# cable oob
Router(config-oob)# static-pseudowire ndf2 type ndf id 12
Router(config-oob-spw)# dest-ip 232.1.1.10 source-ip 10.10.10.5
Router(config-oob-spw)# session-id 0x2
```

This example shows how to configure downstream OOB NDF profile.

```
Router# configure terminal
Router(config)# controller downstream-oob NDF-profile id 100
Router(config-profile)# no ds-channel 0 rf-mute
Router(config-profile)# no ds-channel 0 shutdown
Router(config-profile)# ds-channel 0 frequency 70000000
Router(config-profile)# ds-channel 0 width 1280000
Router(config-profile)# ds-channel 0 poweradjust -10
```

This example shows how to configure bind NDF static-pseudowire and NDF profile with rf-port.

```
Router# configure terminal
Router(config)# cable rpd node6
Router(config-rpd)# core-interface TenGigabitEthernet 7/1/0
Router(config-rpd-core)# rpd-ds 0 static-pseudowire ndf0 profile 100
Router(config-rpd-core)# rpd-ds 0 static-pseudowire ndf1 profile 101
Router(config-rpd-core)# rpd-ds 0 static-pseudowire ndf2 profile 102
```

Example: NDR Configuration

This example shows how to configure static-pseudowire for NDR.

```
Router# configure terminal
Router(config)# cable oob
Router(config-oob)# static-pseudowire ndr0 type ndr id 19
Router(config-oob-spw)# server-ip 192.168.69.1
```

```
Router(config-oob-spw)# mtusize 1500
Router(config-oob-spw)# per-hop-behavior default
Router(config-oob-spw)# session-id 0x3
```

This example shows how to configure upstream OOB NDR profile.

```
Router# configure terminal
Router(config)# controller upstream-oob NDR-profile id 100
Router(config-profile)# no us-channel 0 shutdown
Router(config-profile)# us-channel 0 frequency 5216000
Router(config-profile)# us-channel 0 width 1280000
Router(config-profile)# us-channel 0 poweradjust -5
```

This example shows how to configure bind NDR static-pseudowire and NDR profile with rf-port.

```
Router# configure terminal
Router(config)# cable rpd node6
Router(config-rpd)# core-interface TenGigabitEthernet 7/1/0
Router(config-rpd-core)# rpd-us 0 static-pseudowire ndr0 profile 100
Router(config-rpd-core)# rpd-us 0 static-pseudowire ndr1 profile 101
Router(config-rpd-core)# rpd-us 0 static-pseudowire ndr2 profile 102
```

Maximum Upstream Channel Frequency Upgrade for NDR Profile

Table 5: Feature History

Feature Name	Release Information	Feature Description
Maximum Upstream Channel Frequency Upgrade for NDR Profile	Cisco IOS XE Dublin 17.15.1y	With this release, the maximum configurable upstream channel frequency is increased from 25.6 Mhz to 65 Mhz. The supported range is 5 Mhz - 65 Mhz.

```
router(config)#controller upstream-OOB NDR-profile id 60
router(config-profile)#us-channel 0 frequency ?
  <5000000-65000000>  OOB upstream channel frequency value
```

Frequency Overlap

Table 6: Feature History

Feature Name	Release Information	Feature Description
Frequency Overlap	Cisco IOS XE Dublin 17.15.1y	The frequency overlap feature allows you to manage overlapping frequencies between DOCSIS channels and Out-Of-Band (OOB) channels in Cisco's cBR8 systems. It is specifically designed for customers to skip frequency validation for OOB with DOCSIS, enabling configuration of other vendors' Remote PHY Devices (RPDs) with overlapping frequencies. This feature maintains frequency validation between DOCSIS channels and Video channels.

Information About Frequency Overlap

The Frequency Overlap Feature is essential for customers requiring flexibility in configuring overlapping frequencies. While it skips validation between DOCSIS and OOB frequencies, it ensures DOCSIS channels and Video channels remain validated to avoid conflicts. This capability is significant for integrating multiple vendor systems smoothly within the network infrastructure.

Restrictions for Frequency Overlap

- Video channels cannot be configured with overlapping frequencies with DOCSIS channels.
- NDR frequency cannot be overlapped. The maximum frequency for NDR is 26MHz, while the minimum frequency for DOCSIS is 28MHz.

Benefits of Frequency Overlap

- Allows configuration of overlapping frequencies between DOCSIS and OOB, facilitating integration with other vendor’s RPDs.
- Maintains frequency validation between DOCSIS and Video channels to ensure network integrity and performance.

Configuration Overview

To disable frequency validation:

1. For downstream: `cable downstream freq-overlap disable`
2. For upstream: `cable upstream freq-overlap disable`

Users receive warnings when disabling frequency overlap validation.

To re-enable frequency validation:

1. For downstream: `no cable downstream freq-overlap disable`
2. For upstream: `no cable upstream freq-overlap disable`

To configure overlapping frequencies between DOCSIS and OOB: Disable frequency validation using the above commands.

Supported Scenarios

The Frequency Overlap Feature supports scenarios where overlapping frequencies between DOCSIS and OOB channels are necessary due to the integration of third-party RPDs. It is not applicable for Video channels overlapping with DOCSIS frequencies.

Feature Information for Narrowband Digital Forward And Narrowband Digital Return

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

Table 7: Feature Information for Narrowband Digital Forward And Narrowband Digital Return

Feature Name	Releases	Feature Information
Narrowband Digital Forward And Narrowband Digital Return	Cisco IOS XE Gibraltar 16.10.1	This feature was introduced on the Cisco cBR Converged Broadband Router.