Time and Frequency Division Multiplexing Configuration

This document provides information on the Cisco cBR-8 series routers support for Time and Frequency Division Multiplexing (TaFDM) feature in DOCSIS 3.1 upstream channels.

Information About TaFDM Support

Using the Time and Frequency Division Multiplexing (TaFDM) method, the OFDMA and SCQAM channels, which are allowed to overlap in DOCSIS 3.1, are also allowed to use the upstream at different times. With the implementation of TaFDM, both OFDMA and SC-QAM can simultaneously operate on separate frequencies. They can also operate on the same frequencies, but in different times.

TaFDM enables the OFDMA capability across the entire spectrum, while retaining the backward compatibility with legacy DOCSIS SC-QAM channels.

TaFDM is typically configured at the controller level. However, it is implemented at the Mac Domain level. Overlapping channels cannot be bound to different Mac Domains.

Overlapping SC-QAM and OFDMA channels using TaFDM may be bonded. However, we recommend this bonding only if the modems are provisioned with UGS flows and another non-overlapping SC-QAM is not available.

For a better performance of UGS flows on overlapped SC-QAM channel, configure OFDMA channel with 50kHz subcarrier spacing, lower symbols per frame, and lower cyclic prefix.

To achieve a higher OFDMA channel traffic throughput, configure OFDMA channel with 25kHz subcarrier spacing, and higher pilot pattern.

Prerequisites for Configuring TaFDM Support

The following prerequisite is applicable to configuring TaFDM configuration:

- All overlapped SC-QAM channels and OFDMA channels on the same port must be bound to the same Mac Domain

- Reserve a minimum 0.8–3.2 MHz OFDMA exclusive spectrum with good signal quality to be used for OFDMA channel IM zone

How to Configure cBR for TaFDM Support

Configuring TaFDM Modulation Profile

The TaFDM modulation profile is used to configure initial ranging, fine ranging and data IUC parameters. To define the TaFDM modulation profile, run the configuration commands, as given in the following example:

```
cable mod-profile-ofdma 450
  subcarrier-spacing 25KHz
  initial-rng-subcarrier 64
  fine-rng-subcarrier 192
  data-iuc 9 modulation 1024-QAM pilot-pattern 11
  data-iuc 10 modulation 512-QAM pilot-pattern 11
  data-iuc 11 modulation 256-QAM pilot-pattern 8
  data-iuc 12 modulation 128-QAM pilot-pattern 8
  data-iuc 13 modulation 64-QAM pilot-pattern 8

cable mod-profile-ofdma 470
  subcarrier-spacing 50KHz
  initial-rng-subcarrier 64
  fine-rng-subcarrier 192
  data-iuc 9 modulation 1024-QAM pilot-pattern 1
  data-iuc 10 modulation 512-QAM pilot-pattern 1
  data-iuc 11 modulation 256-QAM pilot-pattern 1
  data-iuc 12 modulation 128-QAM pilot-pattern 1
  data-iuc 13 modulation 64-QAM pilot-pattern 1
```

Configuring I/O Controller for TaFDM

The following sample configuration defines a shared region in the areas of the SC-QAM upstream channels.

```
controller Upstream-Cable slot/subslot/port
  us-channel 0 frequency 35800000
  us-channel 0 channel-width 6400000 6400000
  us-channel 0 docsis-mode atdma
  us-channel 0 minislot-size 2
  us-channel 0 modulation-profile 221
  us-channel 0 equalization-coefficient
  no us-channel 0 shutdown
  us-channel 1 frequency 29400000
  us-channel 1 channel-width 6400000 6400000
  us-channel 1 docsis-mode atdma
  us-channel 1 minislot-size 2
  us-channel 1 modulation-profile 221
  us-channel 1 equalization-coefficient
  no us-channel 1 shutdown
  us-channel 2 frequency 23000000
  us-channel 2 channel-width 6400000 6400000
  us-channel 2 docsis-mode atdma
  us-channel 2 minislot-size 2
```

```
us-channel 2 modulation-profile 221
us-channel 2 equalization-coefficient
no us-channel 2 shutdown
us-channel 3 frequency 16600000
us-channel 3 channel-width 6400000 6400000
us-channel 3 docsis-mode atdma
us-channel 3 minislot-size 2
us-channel 3 modulation-profile 221
us-channel 3 equalization-coefficient
no us-channel 3 shutdown
```

Enhancing OFDMA Channel Throughput

The following example shows how to enhance the OFDMA channel throughput:

```
controller Upstream-Cable 1/0/0
  …
  us-channel 12 docsis-mode ofdma
  us-channel 12 subcarrier-spacing 25KHz
  us-channel 12 modulation-profile 450
  us-channel 12 frequency-range 10000000 85000000    #Overlap with SC-QAM channels
  us-channel 12 initial-rng-frequency-start 50000000    # Specify the preferred start
frequency for IM zone
  us-channel 12 cyclic-prefix 96 roll-off-period 64
  us-channel 12 symbols-per-frame 9
  no us-channel 12 shutdown
```

Enhancing SC-QAM Channel UGS Flow Performance

The following example shows how to enhance the UGS flow performance of the SC-QAM channel:

```
controller Upstream-Cable 1/0/0
  …
  us-channel 12 docsis-mode ofdma
  us-channel 12 subcarrier-spacing 50KHz
  us-channel 12 modulation-profile 470
  us-channel 12 frequency-range 10000000 85000000    #Overlap with SC-QAM channels
  us-channel 12 initial-rng-frequency-start 50000000   #Specify the preferred frequency for
 IM zone
  us-channel 12 cyclic-prefix 96 roll-off-period 64
  us-channel 12 symbols-per-frame 8
  no us-channel 12 shutdown
```

Configuring Cable Interface-MAC Domain

The following example shows how to configure a cable interface for MAC Domain:

```
interface Cable1/0/0
  load-interval 30

  upstream 0 Upstream-Cable 1/0/0 us-channel 0
  upstream 1 Upstream-Cable 1/0/0 us-channel 1
  upstream 2 Upstream-Cable 1/0/0 us-channel 2
  upstream 3 Upstream-Cable 1/0/0 us-channel 3
  upstream 6 Upstream-Cable 1/0/0 us-channel 12
  cable upstream bonding-group 1
    upstream 0
    upstream 1
```

```
      upstream 2
      upstream 3
      attributes 80000000
   cable upstream bonding-group 2
      upstream 0
      upstream 1
      upstream 2
      upstream 3
      upstream 6
      attributes 80000000
   cable bundle 1
   cable sid-cluster-group num-of-cluster 2       #Maximize single modem throughput
   cable sid-cluster-switching max-request 4
   cable cm-status enable 3 6-11 16-18 20-27
   cable privacy accept-self-signed-certificate
```

Configuring Service Class

The following example shows how to configure service classes:

```
cable service class 198 name mega_up
cable service class 198 upstream
cable service class 198 max-concat-burst 16384
cable service class 198 max-rate 1000000000     # Maximize single modem throughput
cable service class 198 max-burst 250000
cable service class 198 priority 0
cable service class 198 peak-rate 0
```

Excluding a Frequency Band from TaFDM

If you want the SC-QAM to exclusively use a specific frequency range, configure Cisco cBR to exclude the band using the following sample commands.

```
controller Upstream-Cable slot/subslot/port
 cable frequency-exclusion-band 18700000 22100000
```

Verifying TaFDM Configuration

The following example shows how to verify the TaFDM configuration:

```
# show controllers upstream-Cable slot/subslot/port us-channel uschan-number-in-controller

#show controllers upstream-Cable slot/subslot/port us-channel uschan-number-in-controller
cdm-ump

# show interfaces cable slot/subslot/port mac-scheduler uschan-number-in-mac-domain
```

Configuration Example

TaFDM Configuration

```
controller Upstream-Cable 1/0/0
  us-channel 0 frequency 15000000
```

```
us-channel 0 channel-width 3200000 3200000
us-channel 1 frequency 22000000
us-channel 1 channel-width 6400000 6400000
us-channel 2 frequency 29000000
us-channel 2 channel-width 6400000 6400000
us-channel 3 frequency 36000000
us-channel 3 channel-width 6400000 6400000
us-channel 4 frequency 11000000
us-channel 4 channel-width 1600000 1600000
us-channel 12 frequency-range 14000000 85000000
```

Feature Information for TaFDM Configuration

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

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

Table 1: Feature Information for for TaFDM Configuration

Feature Name	Releases	Feature Information
TaFDM Configuration	Cisco IOS XE Fuji 16.7.1	This feature was introduced on the Cisco cBR Series Converged Broadband Routers.