



# CMTS Latest Best Practices

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# Agenda

- D2.0 & 3.0 Load Balance
- D3.0 DS Resiliency and Partial Mode
- D3.1 OFDM DS & Graceful Profile Management
- D3.1 OFDMA US Modulation Profile
- US Controller
- Cable Interface
- R-PHY – DLM & CIN Considerations
- New Features in 16.12 IOS & Beyond
- New Commands

# D2.0 Load Balance

# 1. Configure D2.0 Global Settings

- `cab load-balance d20-ggrp-default method utilization`
- `cab load-balance d20-ggrp-default policy pure-ds-load`
- `cab load-balance d20-ggrp-default init-tech-list 4`
- `cab load-balance d20-ggrp-default interval 45`
- `cab load-balance d20-ggrp-default threshold load 15`
- `cab load-balance d20-ggrp-default docsis-policy 1`
- `cab load-balance docsis-enable`
- `cab load-balance modem max-failures 20`
- `cab load-balance method-utilization min-threshold 50`
- `cab load-balance method-utilization cm-hold 900`
- `cab load-balance rule 1 disable-throughput-lower us 100`
- `cab load-balance rule 2 disable-throughput-lower ds 500`
- `cab load-balance docsis-policy 1 rule 1`
- `cab load-balance docsis-policy 1 rule 2`

## D2.0 LB Step-by-Step Suggestions

2. Make proper RLBGs if necessary
  3. Configure any “exclude” statements needed
  4. Config `load-interval 30` on all Cab, I, M, & W interfaces
  5. Configure all fiber nodes
  6. Use: `cab load-balance d20 GLBG auto-generate`
    - ✓ **Note:** From exec mode, do `wr mem` afterward to save all LBGs
  7. Reboot CMs if already online
- **Warning:** 690338923 - P3 - Comcast - 16.12.1z - SUP Crash After Removal of D2.0 LB Groups
    - ✓ CSCvw80040 - Crash caused by no-ing anything out of load-balance group that is not there
      - Cleared everything out of group and then attempted to remove upstream again and this crashed sup
      - For LBG recreation, using “`cable load-balance d20 GLBG auto-generate renew`” may not need manual fix

# D3.0 Load Balance

# 1. Configure D3.0 Global Settings

- `cable load-balance d30-ggrp-default policy pure-ds-load`
- `cable load-balance d30-ggrp-default init-tech-list 4`
- `cable load-balance d30-ggrp-default threshold load 20`
- `cable load-balance d30-ggrp-default interval 30`
- `cable load-balance d30-ggrp-default docsis-policy 1`
- `cable load-balance docsis-enable`
- `cable load-balance docsis30-enable`
- `cab load-balance modem max-failures 10 (maybe 20)`
- `cab load-balance method-utilization min-threshold 50`
- `cable load-balance method-utilization cm-hold 900`
- `cab load-balance rule 1 disable-throughput-lower us 100`
- `cab load-balance rule 2 disable-throughput-lower ds 500`

## D3.0 LB Step-by-Step Suggestions

2. Make proper RLBGs & “exclude” commands if necessary
3. Config `load-interval 30` on all Cable, I, M, & W interfaces
4. Configure cable interface commands
  - ✓ `cable upstream balance-scheduling`
  - ✓ `cable up ranging-init-technique 2`
5. Configure all fiber nodes
6. Reboot CMs if already online
  - ✓ Wait for modem-count LB and primary distribution
7. Configure;
  - ✓ `cab load-balance d30-ggrp-default method util`
  - ✓ `cab load-balance docsis30-enable dynamic down`
  - ✓ `cab load-balance docsis-policy 1 rule 1`
  - ✓ `cab load-balance docsis-policy 1 rule 2`
  - ✓ Rebuild all FNs or change all auto-generated D3.0 LBGs to method utilization
8. Reboot CMs if already online (may not be needed)



# D3.0 DS - DBG & RBG

## DS Resiliency and Partial Mode

# DS Resiliency and Partial Mode

- (config)#cab rf-change-trig percent 75 second (no count)
- (config)#cab cm-status all holdoff 500 reports 5
- (config)#cab rf-change-dampen-time 60 or 90
- (config)#cab acfe enable
- (config)#cab acfe period 60
- (config)#cab acfe guar-bw-sync-period 240
- (config)#cab resiliency ds-bonding
- **Configure 4-6 RBGs per controller (more if battery mode used)**
  - ✓ (config)#interface wideband-cable x/y/z:63  
(config-if)#cable ds-resiliency
- **Remove DBG LB feature**
  - ✓ no cable dynamic-bonding-group load-balance
  - ✓ **Note:** Reclaim of wideband interfaces within 2-3 minutes if no CMs
    - Reclaim of DBG created wideband interfaces same if no CMs, but if > 80% exhausted, WB interface matches reclaim condition (cab dynamic-bonding-group reclaim-threshold percent 5 modems 6) also considered for reclaim

## CM Status

- CM Status 1 & 4 used for MDD
  - ✓ Should we ignore?
    - Seems Commscope/Arris ignore and have less partial mode CMs
  - ✓ What about D3.1 OFDM DS partial mode when Uncorr FEC on Profile A
    - CM status 2 for FEC unlock should cover this
- Hold-off and Reports - `holdoff 500 reports 5`
  - 5 reports every 10 sec
  - Helps when CM in US partial mode & T4 multiplier affects
- **Note:** CM Status Ack in D3.1 CMs & some D3.0 CMs will not abide by reports total

# D3.0 US - Resiliency and Partial Mode

# Data Burst MER Partial Mode

- Legacy US partial mode on by default and based on SM bursts
  - Usually 16-QAM used for SM mod profile
    - ✓ Too robust compared to data at 64-QAM
  - US bonding T4 multiplier makes SM 4 timers longer between updates
- New feature for user-configurable thresholds
  - `cab up resiliency data-burst snr 24 ufec 1 cfec 0 hysteresis 4`
  - Tracks per-CM MER & FEC counters to make decisions to “suspend” data or not on an US ch

# D3.1 OFDM DS

## D3.1 DS Configuration Steps

1. Configure mixed-modulation profile (Optional)
2. Configure OFDM channel profile
3. Configure OFDM spectrum on RF port
  - ✓ Options to define exclusion bands
4. Configure RF ch with freq, ch width and OFDM ch profile
  - ✓ Other optional settings
5. Add OFDM ch to cable interface if using as primary
  - ✓ Not required
6. Define wideband interface that includes OFDM ch
  - ✓ Add D3.0 DSs if required

## Define OFDM Mixed-Modulation Profile

cable downstream ofdm-modulation-profile 102

- subcarrier-spacing 25KHZ
- width 192000000
- start-freq 708000000
- assign modulation-default 1024-QAM
- assign modulation 256-QAM range-subcarriers freq-abs  
860000000 width 40000000



## OFDM Ch Profile in Global Config

cable downstream ofdm-chan-profile 25

- cyclic-prefix 192 (default = 1024)
- interleaver-depth 16
- pilot-scaling 48
- roll-off 128
- guardband-override 1000000 (default = not used)
- subcarrier-spacing 25KHZ (default = 50 kHz)
- profile-control modulation-default 256-QAM (Used for MDDs)
- profile-data 1 modulation-default 1024-QAM
- profile-data 2 modulation-default 2048-QAM
- profile-data 3 modulation-profile 102
  - ✓ Some CMs may have issues with more than 3
- profile-data 4 modulation-default 4096-QAM
- profile-ncp modulation-default 64-QAM (default = 16-QAM)

# Configure OFDM Spectrum on Controller & Associate with RF Ch

## controller integrated-cable 1/0/0

- max-ofdm-spectrum 192000000
- max-carrier 32
- base-channel-power 37 (Range for this channel load = 30 to 39 dB)
- power-tilt cable 8 max-frequency 900000000
  - ✓ Optional tilt function available for all rf on entire controller
- ofdm-freq-excl-band start-freq 7700000000 width 100000000
  - ✓ **Note:** Option for exclusion zones
- rf-chan 0 31
  - ✓ type DOCSIS
  - ✓ frequency 5190000000
  - ✓ rf-output NORMAL
  - ✓ power-adjust 0.0 (Can be set power +/- 4 dB depending on base power)
  - ✓ qam-profile 1
- rf-chan 158
  - ✓ ofdm channel-prof 25 start-freq 7080000000 width 192000000 plc 800000000
    - **Note:** PLC can be configured but default (centered) usually fine
  - ✓ power-adjust 0.0 (May want higher for better MER)

## OFDM Primary Channel? & DS Bonding Group

- interface Cable1/0/0
  - ✓ downstream Integrated-Cable 1/0/0 rf-channel 0
  - ✓ downstream Integrated-Cable 1/0/0 rf-channel 8
  - ✓ downstream Integrated-Cable 1/0/0 rf-channel 16
  - ✓ downstream Integrated-Cable 1/0/0 rf-channel 24
  - ✓ downstream Integrated-Cable 1/0/0 rf-channel **158 ?**
  - ✓ cable bundle 1
  - ✓ ..... .
- interface Wideband-Cable1/0/0:10
  - ✓ cable bundle 1
  - ✓ cable rf-channels channel-list 0-31 **158**

# D3.1 OFDM DS Graceful Profile Management

## D3.1 DS Graceful Profile Management

- `cab down ofdm-prof-mgmt prof-dwngrd-auto`
- `cab down ofdm-prof-mgmt rxmer-poll-interval 60`
- `cab down ofdm-prof-mgmt recommend-profile-age 120`
- `cab down ofdm-prof-mgmt unfit-profile-age 60`
- `cab down ofdm-prof-mgmt exempt-sc-pct 10`
- `cab down ofdm-prof-mgmt mer-margin-qdb 12`
- `cab down ofdm-flow-to-profile profile-data 1 mac-address dead.beef.cafe`
  - ✓ **Note:** Can manually configure CM to profile in global config, maybe for test equipment
    - This has priority over other settings and CM must be reset – new code doesn't require
    - Can select interface ch when 2 OFDM present

# D3.1 OFDMA US Modulation Profile

## D3.1 US Modulation Profile

`cable mod-profile-ofdma 427`

- `subcarrier-spacing 25KHz`
- `initial-rng-subcarrier 64`
- `fine-rng-subcarrier 128`
- `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 11`
- `data-iuc 12 modulation 128-QAM pilot-pattern 11`
- `data-iuc 13 modulation 64-QAM pilot-pattern 11`
- **Note:** 2K and 4K-QAM not officially supported but configurable

# US Controller



## Controller Upstream-Cable 1/0/0

- `us-channel 0 frequency 16000000`
- `us-channel 0 channel-width 6400000 6400000`
- `us-channel 0 threshold snr-profiles 24 19`
- `us-channel 0 threshold corr-fec 0`
- `us-channel 0 threshold hysteresis 4`
- `us-channel 0 docsis-mode atdma`
- `us-channel 0 minislot-size 2`
- `us-channel 0 modulation-prof 224 223 222`
- `us-channel 0 equalization-coefficient`
- `no us-channel 0 shutdown`
- **Note:** upstream chs 1, 2, & 3 at 22500000, 29000000, 35500000

## Contr Upstream-Cab 1/0/0 (cont)

- `cable ofdma-frequency-exclusion-band 46000000 48200000`
  - **Note:** OFDMA ch will never use freqs in **exclusion band**, but can place legacy SC-QAM in this band
- `cable ofdma-frequency-unused-band 50000000 52000000`
  - **Note:** OFDMA will not use freqs in **unused band** for data traffic but will send probes in them
- `us-channel 12 docsis-mode ofdma`
- `us-channel 12 subcarrier-spacing 25KHz`
- `us-channel 12 modulation-profile 427`
- `us-channel 12 frequency-range 45000000 85000000`
- `us-channel 12 initial-rng-frequency-start 80000000`
  - **Note:** initial ranging freq can be set, but default = 1/3 above start of OFDMA
- `us-channel 12 cyclic-prefix 96 roll-off-period 64`
- `us-channel 12 symbols-per-frame 12`
- `us-ch 12 data-iuc 10 band 60000000 65000000 modu 512-QAM pilot-pat 11`
  - **Note:** can statically set modulation in freq range if needed
- `us-channel 12 equalization-coefficient`
- `no us-channel 12 shutdown`
- **Note:** One OFDMA block for R-PHY & 2 supported for Integrated, but only 192 MHz max across controller pair on Cylons card

## OFDMA IUC Selection Settings

- `cable upstream ofdma-prof-mgmt rxmer-poll-interval 10`  
✓ Default = 60 min
- `cable upstream ofdma-prof-mgmt prof-upgrade-auto`  
✓ Default = on
- `cable upstream ofdma-prof-mgmt exempt-mslot-pct 0`  
✓ Default = 0%
- `cable upstream ofdma-prof-mgmt mer-margin-qdb 0`  
✓ Default = 0, ¼ dB

- **Note: New US Avg MER**

✓ `scm 9058.515c.9c30 prof up | i Mean`  
Active Subcarrier RxMER Mean : 44.00 0xB0

✓ `sh cab upstream ofdma mer-f | in 1/0/2|MER`

Upstream:IUC	MER(dB)	TotalFecCW	CorrectedFecCW	UncorrFecCW	UncorrCW%	MD:upstream
UC1/0/2:U12:IR	0.00	34	34	0	0.0	Ca1/0/2:u6
UC1/0/2:U12:FR	0.00	79053	79053	0	0.0	Ca1/0/2:u6
UC1/0/2:U12:IUC10	41.25	2112412903	114938895	0	0.0	Ca1/0/2:u6
UC1/0/2:U12:IUC11	0.00	0	0	0	0.0	Ca1/0/2:u6
UC1/0/2:U12:IUC12	0.00	0	0	0	0.0	Ca1/0/2:u6
UC1/0/2:U12:IUC13	41.50	2608294	0	0	0.0	Ca1/0/2:u6



# Cable Interface

# Cable Interface Config Suggestions

```
interface Cable1/0/0
load-interval 30
down Integrated-Cable 1/0/0 rf-ch 0
down Integrated-Cable 1/0/0 rf-ch 8
up 0 Upstream-Cab 1/0/0 us-channel 0
up 1 Upstream-Cab 1/0/0 us-channel 1
up 2 Upstream-Cab 1/0/0 us-channel 2
up 3 Upstream-Cab 1/0/0 us-channel 3
up 4 Upstream-Cab 1/0/0 us-channel 12
cab up 0 power-adjust continue 6
```

## **Note: Set for all USs**

```
cab up balance-scheduling
!cab up ranging-init-technique 2
cab up max-channel-power-offset 6
!cab up ranging-poll t4-multiplier 2
cab upstream resiliency sf-move RTPS
cab up resiliency sf-move NRTPS
cab up resiliency sf-move UGS
cable upstream qos fairness
cab up resiliency data-burst snr 24 ufec 1 cfec 0 hysteresis 4
```

```
cab upstream bonding-group 100
    upstream 0
    upstream 1
    upstream 2
    upstream 3
cab upstream bonding-group 101
    upstream 3
    upstream 4
```

```
cab bundle 1
```

```
cab map-advance dynamic 800 600 ?
cab sid-cluster-gr num-of-clust 2
```

## **Note: 16.12.1z added dynamic rate**

```
!cab cm-status enable 9-10
!cab reduction-mode mta-batt enable
!cab reduction-mo energy-man enable
```

## **Note: US BGs must be USs 0-7 or 8-15**

# R-PHY – DLM & CIN Considerations

## DLM Suggestions

- DLM not on by default, suggest `measure-only`

```
cable rpd typical_rpd
  core-interface Te2/1/0
    network-delay dlm 1 measure-only
```

- Monitor DLM with `show cable rpd <mac> dlm`

➤ If exceeds default of 500  $\mu$ s, then use

```
cable rpd long_rpd
  core-interface Te2/1/0
    network-delay dlm 1
```

- If high jitter, may be necessary to statically set network delay to worst case value

```
cable rpd jitter_rpd
  core-interface Te2/1/0
    network-delay static 2000
```

# CIN Considerations

- Long CIN designs may require DPS
  - `cbr8 (config-if) #cable upstream dps`
    - ✓ Officially supported in 17.3.1w
- Aggressive Map Advance ( $< 2500 \mu\text{s}$ ) could justify increasing Map Advance “safety” to achieve at least 2500
  - Monitor Map Advance values and verify above 2500  $\mu\text{s}$  for all USs
    - ✓ `cbr8#show controllers cable x/y/z upstream | inc Dyn`
- Configure Map Advance under cable interface
  - `cbr8 (config-if) #cable map-advance dynamic 1200`
    - ✓ Range of 300 to 1500  $\mu\text{s}$  (default 1000  $\mu\text{s}$ )
    - ✓ Static?
  - **Note:** DPS may add delay to map messages
  - **Note:** OFDMA will increase Map Advance – potentially an extra 1 ms!





# New Features & Commands in 16.12 IOS & Beyond

# New Features in 16.12.1x IOS

- DPIC 100 G card supports following SFP+/QSFP in 16.12.1
  - Meant for Kobol-R card, Gen 2 LC
  - QSFP-100GE-LR, SR and SM-SR
  - QSFP-40G-LR(4x10Gmode) & SR
  - QSFP-4X10G-AOCxM(4x10Gmode)
    - ✓ Active Optical Cable
- Hitless OFDM Profile Updates
  - Supports adding or removing OFDM profiles from OFDM channel without shutting down or restarting (shut/no shut) of ch
  - Feature used by Profile Management Application (PMA)
  - Flow to profile (D3.1 PMA)
- OFDMA – Four Override Zones per IUC
  - Feature increases number of overrides to four per IUC

## New Features in 16.12.1x IOS (cont)

- Ephemeral Profile to CM Assignment
  - CLI to resolve issue where specific MAC address causes CMTS to forward all user data traffic to that CM on new OFDM data profile
  - CM does not reset when moving to profile
    - ✓ If CMTS receives CM-STATUS 16 for that profile, CMTS downgrades profile automatically
    - ✓ Feature used by Profile Management Application (PMA)
- SNR Smoothing
- Upstream Dynamic Modulation Profile
- US OFDMA Per-CM Codeword Error Monitoring
  - Supports codeword error threshold which profile will be downgraded
    - ✓ Profile switched to lower order QAM

# SNR Smoothing

- Improved stability of per-CM SNR & US channel MER(SNR)
- (config)#cable ranging ?
  - upstream packet <10-80> default is 10 – This is for US Ch MER(SNR) reporting
  - cm packet <1-20> default is 1 – This is for per-CM MER(SNR) reporting
  - deviation <1-3> default is 1 – I never messed with this yet to see results
- IRT upstream packet & US ch SNR smoothing
  - Dynamic modulation uses US ch MER, so smoothing feature will affect it
- IRT cm packet & per-CM SNR smoothing
  - Data Burst MER is used for data burst MER resiliency feature, so no affect
  - Station maintenance (SM) SNR(MER) is used to come out of US partial-suspend mode, so that would affect it

# US Dynamic Mod Profile Support for R-PHY Systems

- **Note:** All USs doing virtual combining (officially not supported) will be dictated by first RPD

➤ Consider OFDMA instead

```
#show controllers upstream-Cable 9/0/10
```

```
Controller RPD US Port List:
```

DevID	RPD ID	US Port	I/F	Name
0	badb.ad13.417c	0	Te9/1/2	uscom3
1	badb.ad13.4200	0	Te9/1/2	uscom4

- CMTS assigns DevID according to sequence of RPD configuration in running-config

# New Commands

- `cbr8(config)#cab modem offline-timeout ?`  
    `<1-4320> Offline timeout (min)`
  - Default is 24 hrs
- New IOS has CLI for US virtual combining; Gen2 (Kobol-R) LC
  - `(config)#cable upstream-sharing ?`  
    `128x8 128 scqam channels and 1:8 sharing ratio per linecard`  
    `256x4 256 scqam channels and 1:4 sharing ratio per linecard`
    - First number is amount of total US SC-QAMs supported per linecard
    - Need to confirm how many OFDMAs supported in these scenarios
- For low-split CMs on mid-split or high-split plant, there is a global config that may help:
  - `cable us-freq-use-cm-cap`
  - Config is supported on 16.7 and 16.10 releases and disabled by default?
    - ✓ Uses CM capability TLV 5.20 to determine if a CM supports standard US freq range or extended
    - ✓ Can view TLV 5.20 under `scm verbose: show cable modem <MAC> verbose | s US Frequency Range Capability`
  - Command will limit TCS assigned by CMTS to CM to US chs within supported freq range reported by CM
    - ✓ CM supporting only standard US freq range should not attempt to range on US chs above 42MHz/65MHz

# New Commands (cont)

- Feature support on 16.7, 16.9, 16.10

- `cbr8(config-if)#cable ?`  
`diplexer-band-edge` Transmit Diplexer Band Edges in MDD
  - ✓ `no cable diplexer-band-edge` under MD config will turn off transmission of MDD TLV 21 (Diplex Band Edge)
- There's no way to disable path selection from using CM's reported diplex settings when selecting RCC/TCC

- 16.12.1z IOS

- D3.1 US Partial Mode Feature
  - ✓ `cable upstream ofdma-prof-mgmt downgrade rxmer-enable`
  - ✓ `ofdma-prof-mgmt downgrade rxmer min-iuc 13` (default)
  - ✓ `cable upstream ofdma-prof-mgmt rxmer-poll-interval 10`
  - ✓ **Note:** Manual probe - `ping docsis pnm f81d.0f01.4bf0 upstream n` (OFDMA US ch)
- Dynamic SID Cluster Threshold
  - ✓ Default of 28 Mbps
  - ✓ `cbr(config-if)#cab sid-cluster-group dynamic ?`
  - ✓ `<1-4294967295> max_rate threshold (bps)`

## New Commands (cont)

- CMs in US bonding partial mode due to bad timing offsets & analog fiber failovers
  - `cable upstream resiliency recover delay <150-86400> (900 default)?`
  - `cable upstream resiliency recover retries <0-5>`
- 17.3.1 adds official support for DPS
  - Not officially supported for OFDMA in first release
- 17.3.1 adds Guaranteed Contention Time
  - `(config-if)#cable upstream min-bwreq-ops scqam 10`
    - ✓ 0 default with 0-20% option (0 means 1 Cont BW Req opportunity every 2 ms during full congestion)
  - Not officially supported for OFDMA in first release
- DBG
  - `cab dynamic-bonding-group` + `"no cable dynamic-bonding-group register"`
  - If manually created BGs and above commands used, no DBG created for CM registration, but DBGs can be created for static and dynamic load balance
  - Maybe good for 4-ch D3.0 CMs?