Dynamic Range Window (DRW)

DOCSIS 3.0 & 3.1 Upstream Tx Levels

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D3.1 US OFDMA Power Level High Points

- CM US **Tx** level reported in 1.6 MHz eq BW (even for SC-QAM)
  - `SCM Phy` **`Norm`** will adjust
- Max 10 dB delta between 6.4 MHz ch & OFDMA on same controller
- More US spectrum = greater coax attenuation & tilt from CM to CMTS
  - US Tx levels
    - ✓ D2.0 max Tx = 54 dBmV
    - ✓ D3.0 max Tx; 4-ch = 51 dBmV, 8-ch = 48 dBmV (**Note**: D3.0 & < based on modulation)
    - ✓ D3.1 max Tx = 65 dBmV total pwr
- Dynamic Range Window (DRW) of 12 dB could be concern with much more potential spectrum allocation (up to 204 MHz) vs 85 for D3.0
  - DRW is different for D3.1 vs D3.0 IRT +/-6 for D3.0, but not same for D3.1

CMTS Config “Band-Aids” & TCS Selection

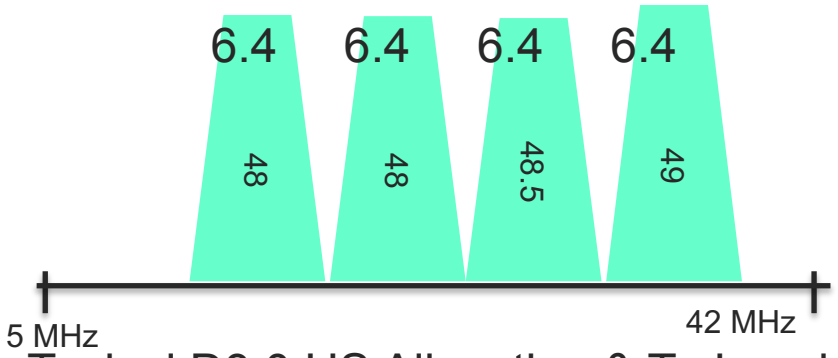
- No US ALC/AGC
  - Relying on CM/CMTS long-loop-level control and CM 12 dB DRW
  - Typical +/-2 dB swing @ 42 MHz (annual thermal fluctuations) w/ 4000’ coax
  - CMTS US level settings and adjustable range
- **Note**: OFDMA level displayed on analyzer affected by amount of traffic
  - Have seen where level does not match expected unless peak hold & send enough PRBS traffic to reach 70-90%
  - More testing needed with zero-span, FFT, longer dwell time/slower sweep speed, etc.

Potential Fixes for Higher US Freqs

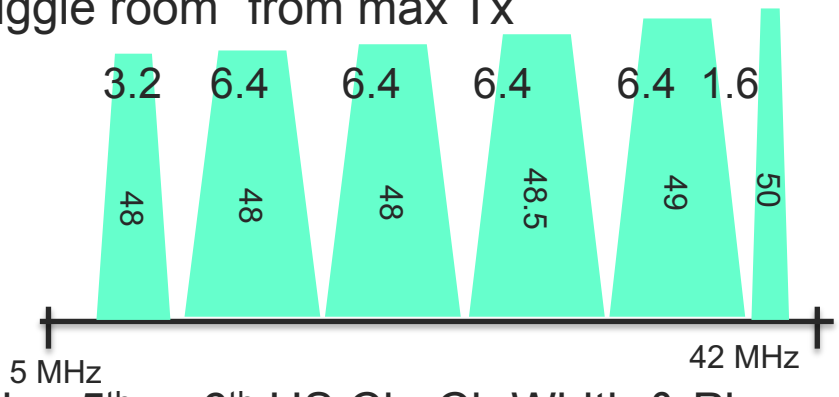
- No coax and move to stable 70^{o} environment ☺
- Flexible Solution Taps (FST) - EQs & InvEQs for levels & DRW issues
  - Field Equalizers (FEQs) at least
  - EQ from 5 -1.2 GHz, no cutoff & grp delay or concern for diplex changes later
- Thermal issues
  - Underground cable
    - ✓ Passives still above ground and experience slight temp fluctuations
  - US thermal EQs to help stabilize negative fluctuations on cold days
    - ✓ Higher noise floor assuming aerial plant
  - Idea of US AGC driven by DS AGC circuitry or Intelligent-Amp
- D3.0 with Extended Pwr ECN = 3-6 dB more US Tx w/54 dBmV typical
- D3.1 is ~ 5 dB more power per equivalent 8-ch D3.0 CM

Typical **D3.0** CM US Tx Levels

- **Off High-Value Tap**
  - First tap off active & more flat loss/attenuation & less “wiggle room” from max Tx



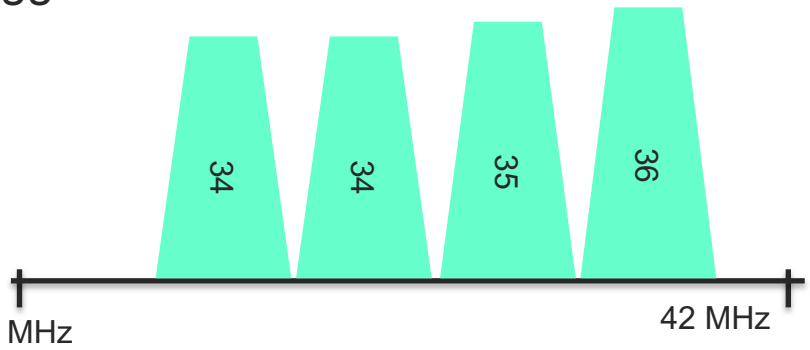
Typical D3.0 US Allocation & Tx Levels



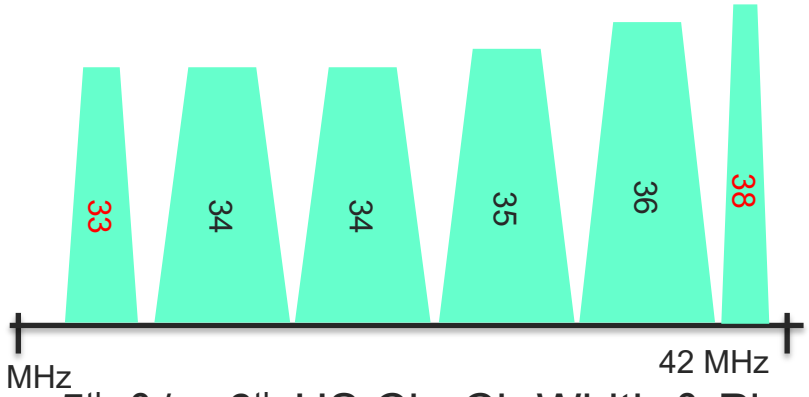
Adding 5th or 6th US Ch, Ch Width & Placement

Note: CM must support 8, but not sure of filter cutoff

- **Off Low-Value Tap**
  - Low value tap indicates end-of-line & more coax causing more attenuation & temperature effects, but more “wiggle room” from max Tx



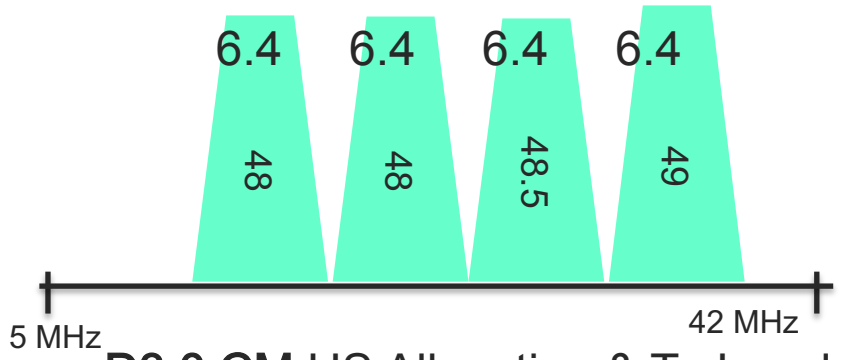
Typical US Allocation & Tx Levels from Coax



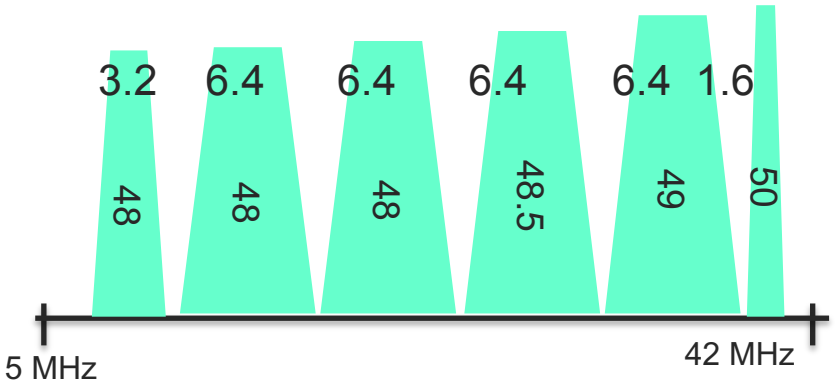
Adding 5th &/or 6th US Ch, Ch Width & Placement

Note: 5 out of 12 dB DRW is fine in 42 MHz plant, but worse in 85 MHz plant

Typical **D3.1** US Tx Levels Based on 1.6 MHz Equivalent BW Off **High-Value** Tap

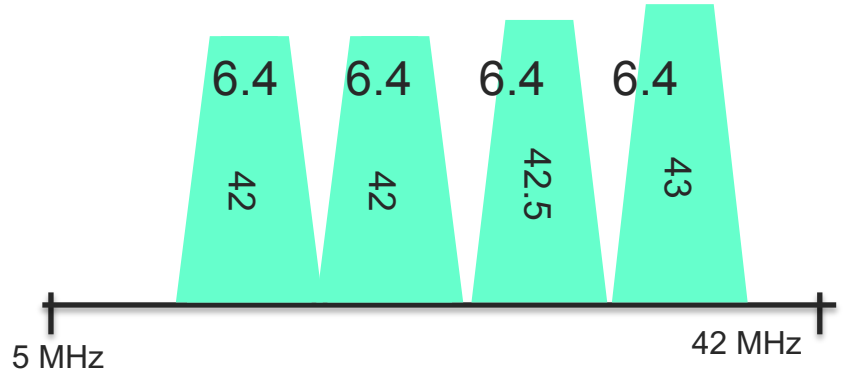


D3.0 CM US Allocation & Tx Levels

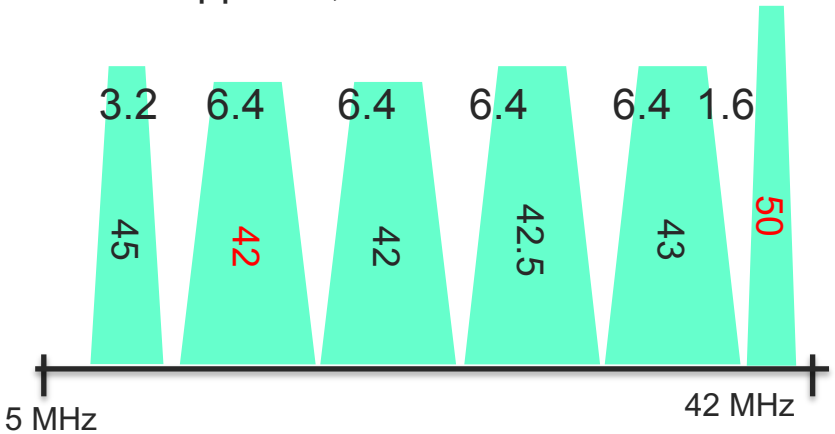


D3.0 CM w/ 5th or 6th US Ch, Ch Width & Placement

Note: CM must support 8, but not sure of filter cutoff



D3.1 CM SC-QAM US Tx Levels

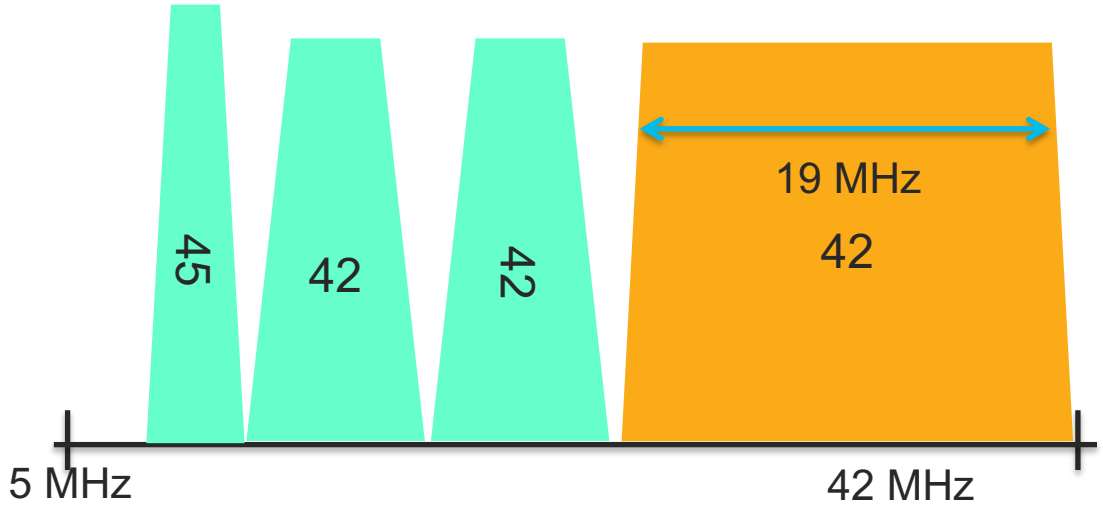


D3.1 CM >4 US Chs, Ch Width & Placement

Note: "Norm" command will provide Tx based on ch width

Note: 8 out of 12 dB DRW is close even in 42 MHz plant

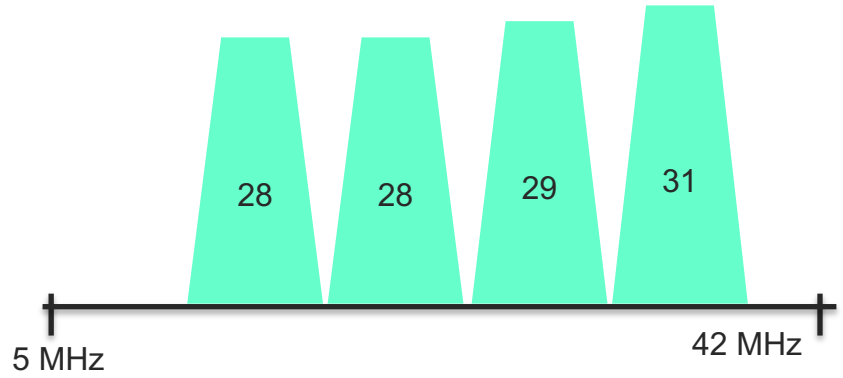
D3.1 US Tx Levels with OFDMA Off **High-Value** Tap



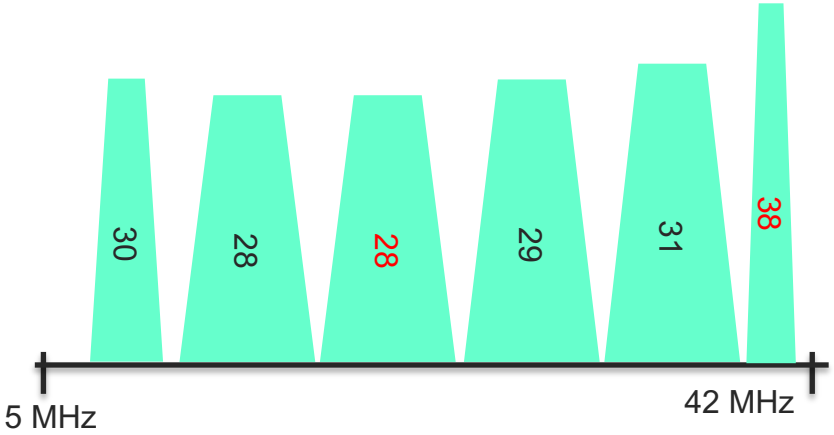
D3.1 CM Preferred/Suggested US Allocation with OFDMA

Note: Level negotiated based on 6.4 MHz & IR freq will affect actual value

Typical **D3.1** US Tx Levels Based on 1.6 MHz Equivalent BW Off **Low-Value** Tap

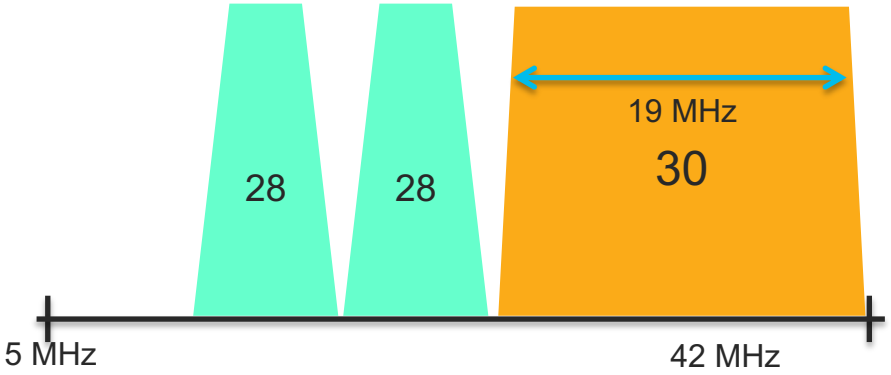


Typical SC-QAM US Allocation & Tx Levels



>4 US Chs, Ch Width & Placement

Note: 10 out of 12 dB DRW is very close in 42 MHz plant!



D3.1 CM Preferred US Allocation with OFDMA

Warning: Disparate SC-QAM US ch widths exacerbates D3.1 CM DRW issue along with more spectrum!

1. Get rid of narrow SC-QAMs in TCS
2. Keep narrow SC-QAM in lower spectrum
3. Manipulate CMTS Rx config

D3.0 Dynamic Range Window (DRW)

- During initial ranging on chs being added by TCC encodings, CM MUST cover entire DRW within 16 retries, leaving no power interval greater than 6 dB untried
  - So for D3.0, by commanding power to mid of window it allows to go either 6 dB above or 6 dB below, which will cover whole 12 dB window
- D30 uses a per-ch DRW, whereas D31 uses a single DRW for all chs in TCC
  - D30 allows bit more flexibility to shift DRW slightly for each ch if need be

D3.1 Dynamic Range Window (DRW)

- CMTS normally administers DRW of 12 dB [DOCSIS MULPIv3.1] which is sufficient to accommodate plant tilts of up to 10 dB from lower to upper edge of US band
- Since fidelity requirements are specified in flat freq conditions from top of DRW, it's desirable to maintain CM Tx power levels as close to top of DRW as possible
- D31 uses single DRW for all chs in TCC
- Three types of DRW violations reported by BRCM D31 CM

3 Types of DRW Violations Reported by BRCM D31 CM

- Type 1:REG-RSP-MP Mismatch Between Calc Value for P1.6hi Compared to CCAP provided value
  - Uncommon & have not seen this reported recently. It could indicate that CMTS has recalculated value of P1.6hi for some reason (should not happen unless CM's TCS has changed)
  - Does not imply loss of service
  - If TCS changes, it is expected
- Type 2:RNG-RSP Commanded Power Exceeds Value Corresponding to Top of DRW
  - Indicates CMTS sent RNG-RSP with commanded power for 1 or more chs exceeding DRW max
  - May be printed by CM once or twice in event of DRW adjustment
  - However, if continuously printed by CM, that indicates problem that should be investigated
- Type 3:RNG-RSP Commanded Power in Excess of 6 dB Below Value Corresponding to top of DRW
  - Indicates one or more chs in TCS has a commanded power value in lower half of DRW
  - More of an informative message, and benign
  - Indicates there may be US power tilt in plant
  - May also be seen in lab with very low attenuation
    - ✓ DRW could be at spec min (range of 17 - 29 dBmV) & CM may be transmitting in lower half of that range

Closing Points

- Larger OFDMA chs will have same MER as 6.4 MHz, but max power issues
  - Could possibly configure lower CMTS Rx level on per-ch basis with pitfall of MER affect
  - What about 2 smaller blocks instead of 1 large block
    - ✓ More overhead and wasted resources
- Is it better to do init ranging on lower freqs, middle or higher?
  - IR freq can be set & very robust modulation (BPSK), but low freqs can be very noisy
  - Very high freqs have more attenuation & TCS selection intended may not happen
  - IR will affect/dictate DRW
  - FR uses QPSK and scattered thru entire ch spectrum
- Using lower freq for OFDMA Initial Ranging (IR) may help with DRW
  - Pre-EQ apparently not part of DRW
- T4 multiplier
- Step attenuators & house filters
- FSTs are good for DRW, but caution advised for end-of-line designs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