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UNLEASH THE POWER OF LIMITLESS CONNECTIVITY

2021 Fall
Technical Forum
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Wireline Access Network

Improving Upstream Efficiency

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2021 Fall Technical Forum
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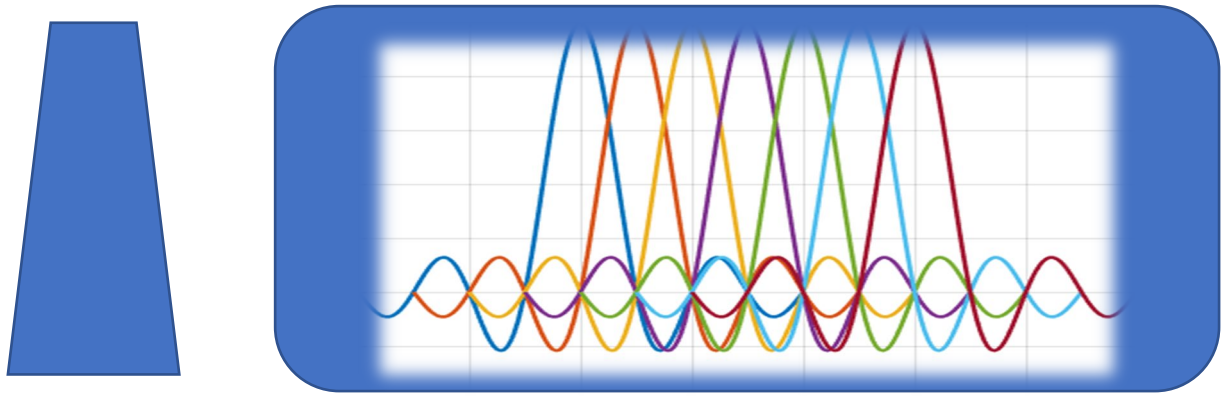
VIRTUAL EXPERIENCE
OCTOBER 11-14

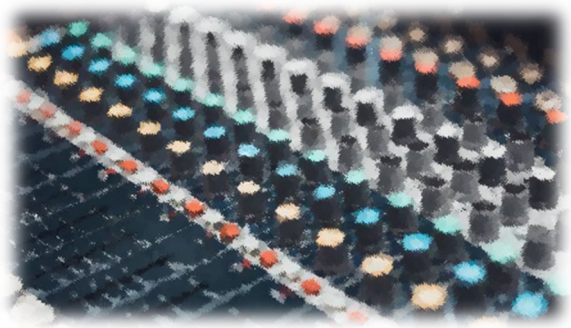
Upstream transition from SC-QAM to OFDMA

- 200/400/800 kHz→ 1.6/3.2/6.4 MHz → ~ 10/30/60/95 MHz
- QPSK → 64 QAM → 1024 QAM (optionally 2048/4096)



Upstream

- Channel Parameters (20+)
- Burst parameters (20+)

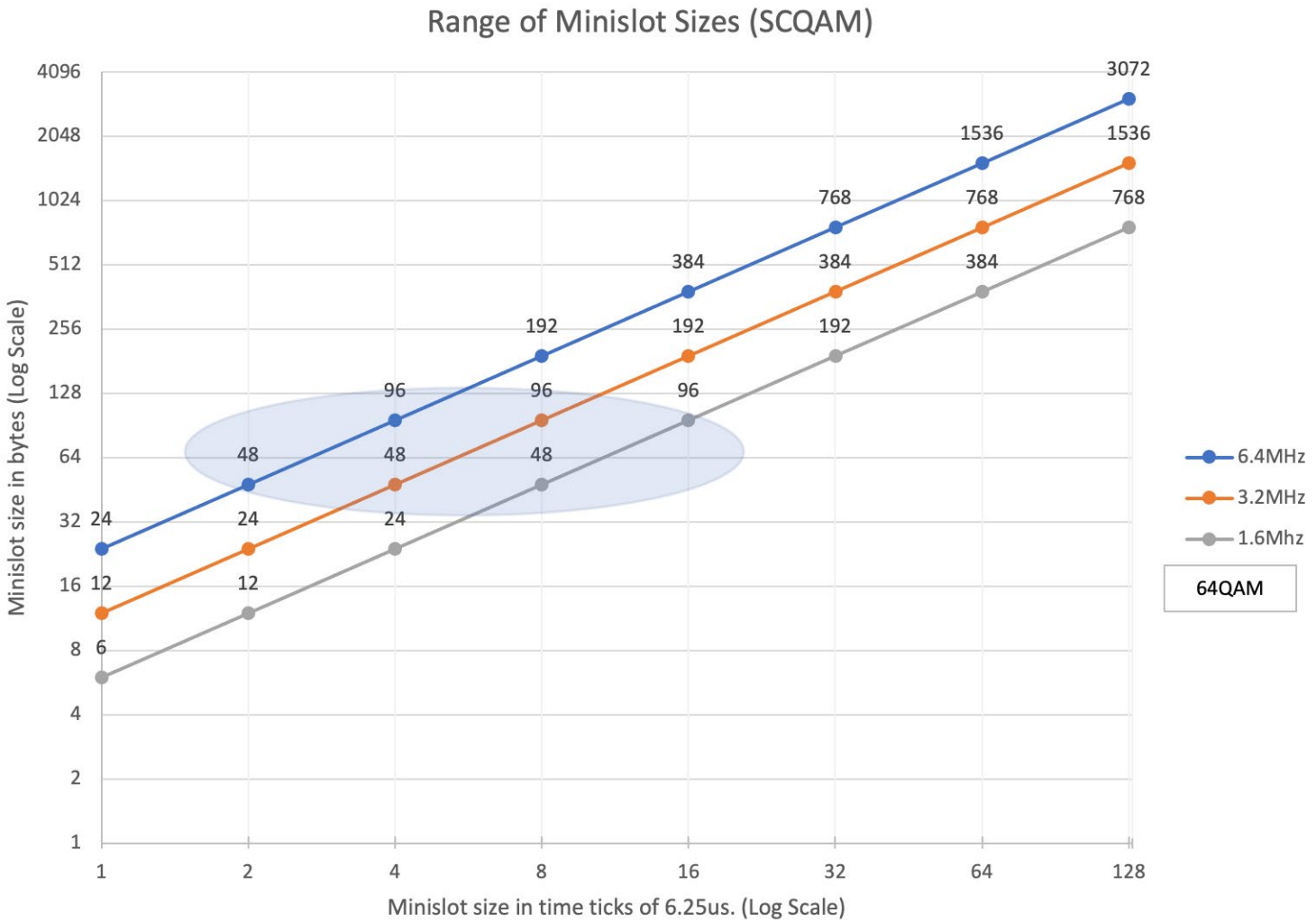


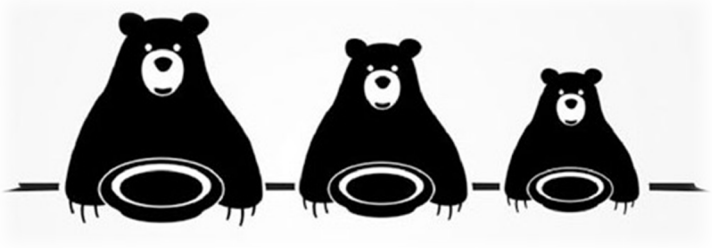
- Lots of settings to optimize
- Default out of the box- not great

Minislot sizes

Choose sizes wisely

- Grant Overhead
- US packet sizes

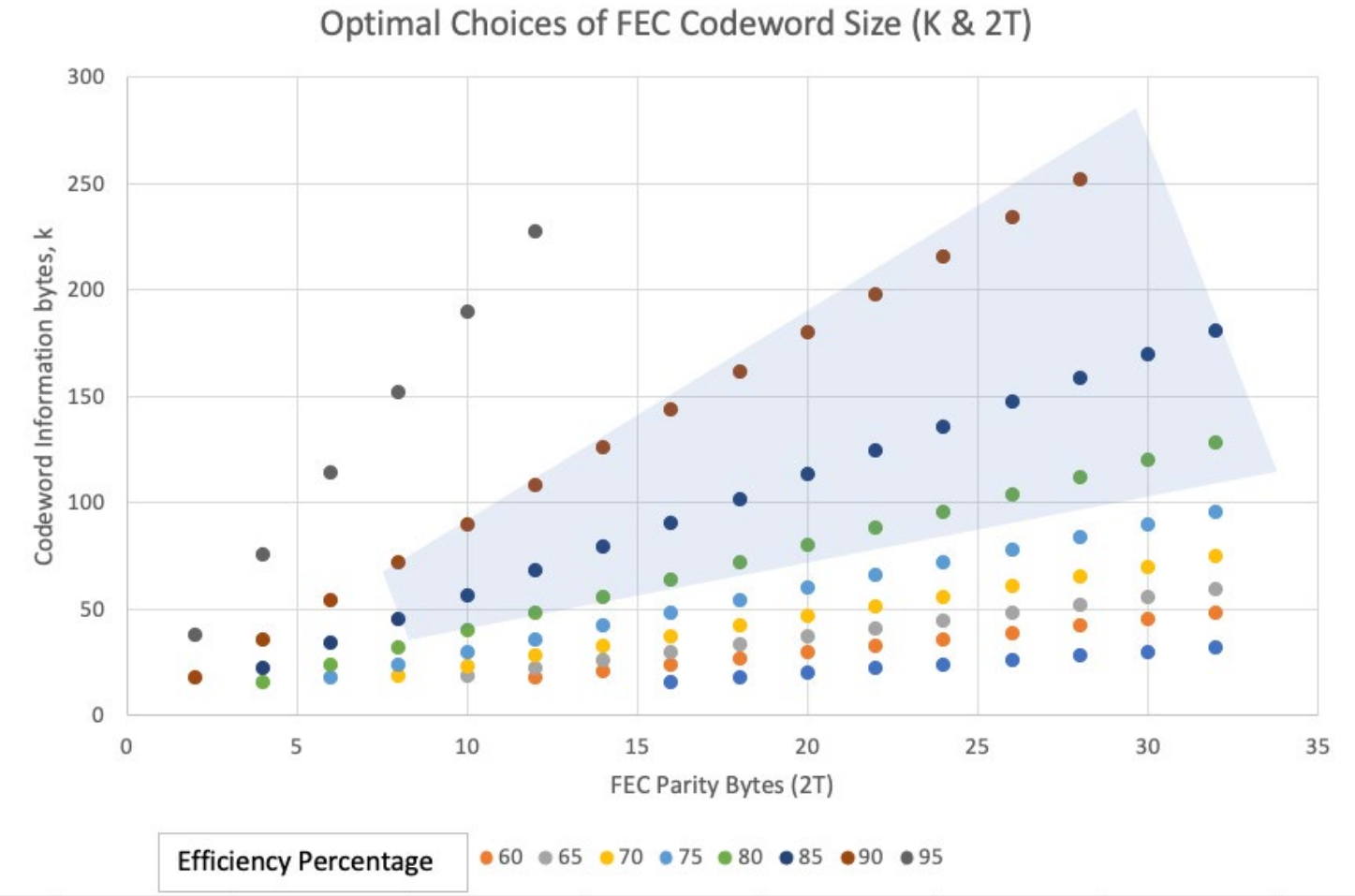




FEC Choices

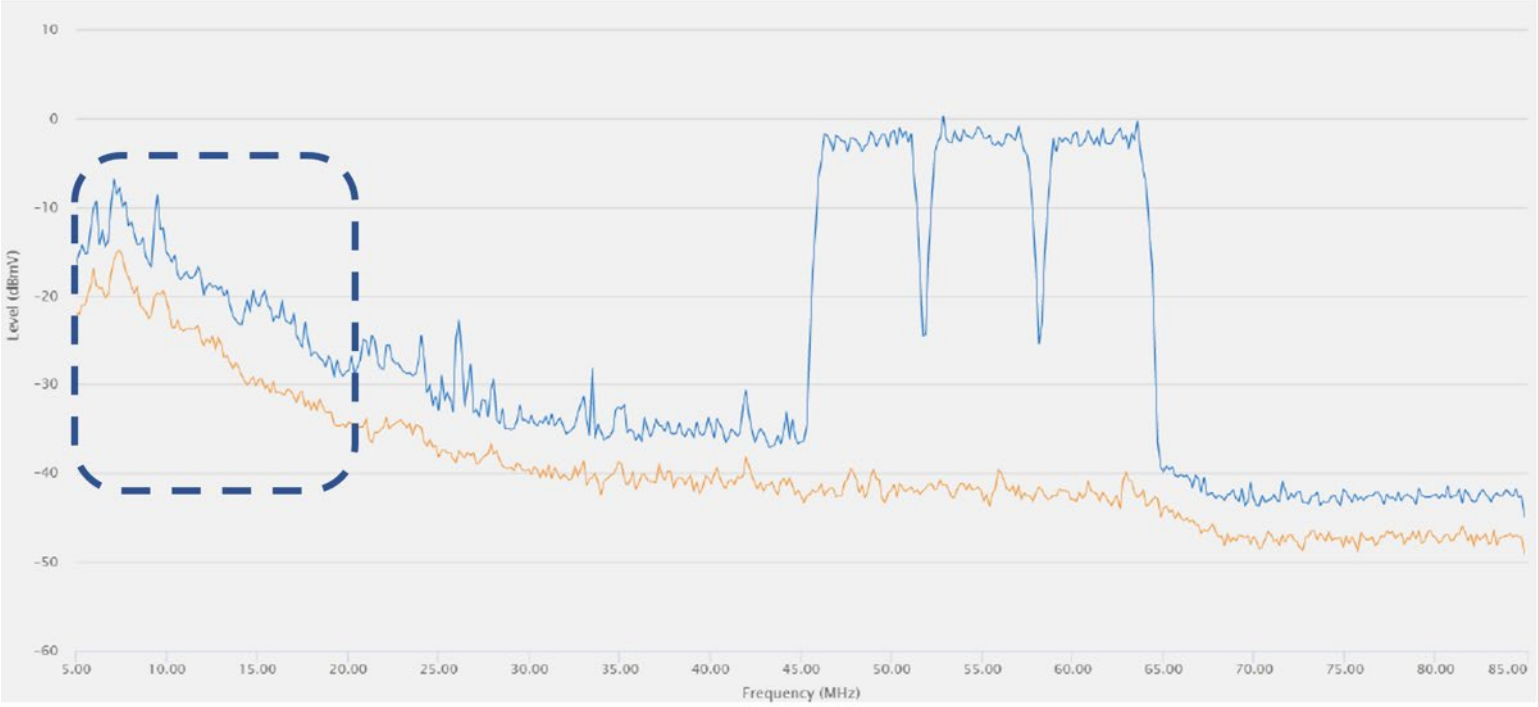
Choose sizes appropriate to plant

- k+2T
- Good range
  - CW efficiency 75-90%



Channel Location

Noisy Spectrum below 20 MHz



Number of Symbols in a frame (K)

With 20 µs FFT duration (2K FFT)

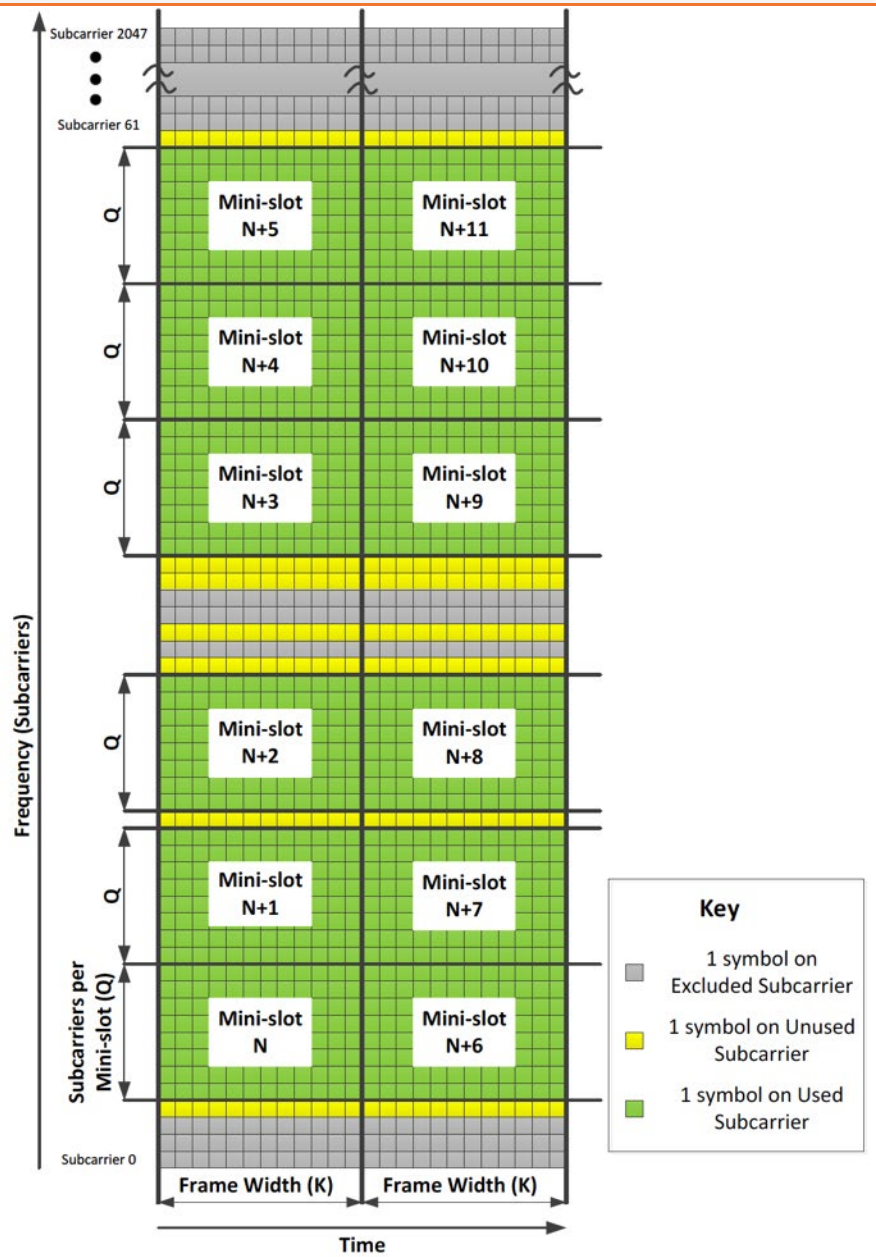
- Kmax = 18/24/36 (for BW≥ 72 MHz, 48 MHz ≤BW < 72 MHz, BW < 48 MHz)

With 40 µs FFT duration (4K FFT)

- Kmax = 9/12/18 (for BW ≥ 72 MHz, 48 MHz≤ BW < 72 MHz, BW < 48 MHz)

- 3% to 5 % increase in throughput with increasing K
  - 6 to 9/18 (75MHz channels) or
  - 6 to 18/36 (for smaller 32 MHz channels)

- Avoid gaps in the channel if possible
  - Edge minislots vs Body minislots



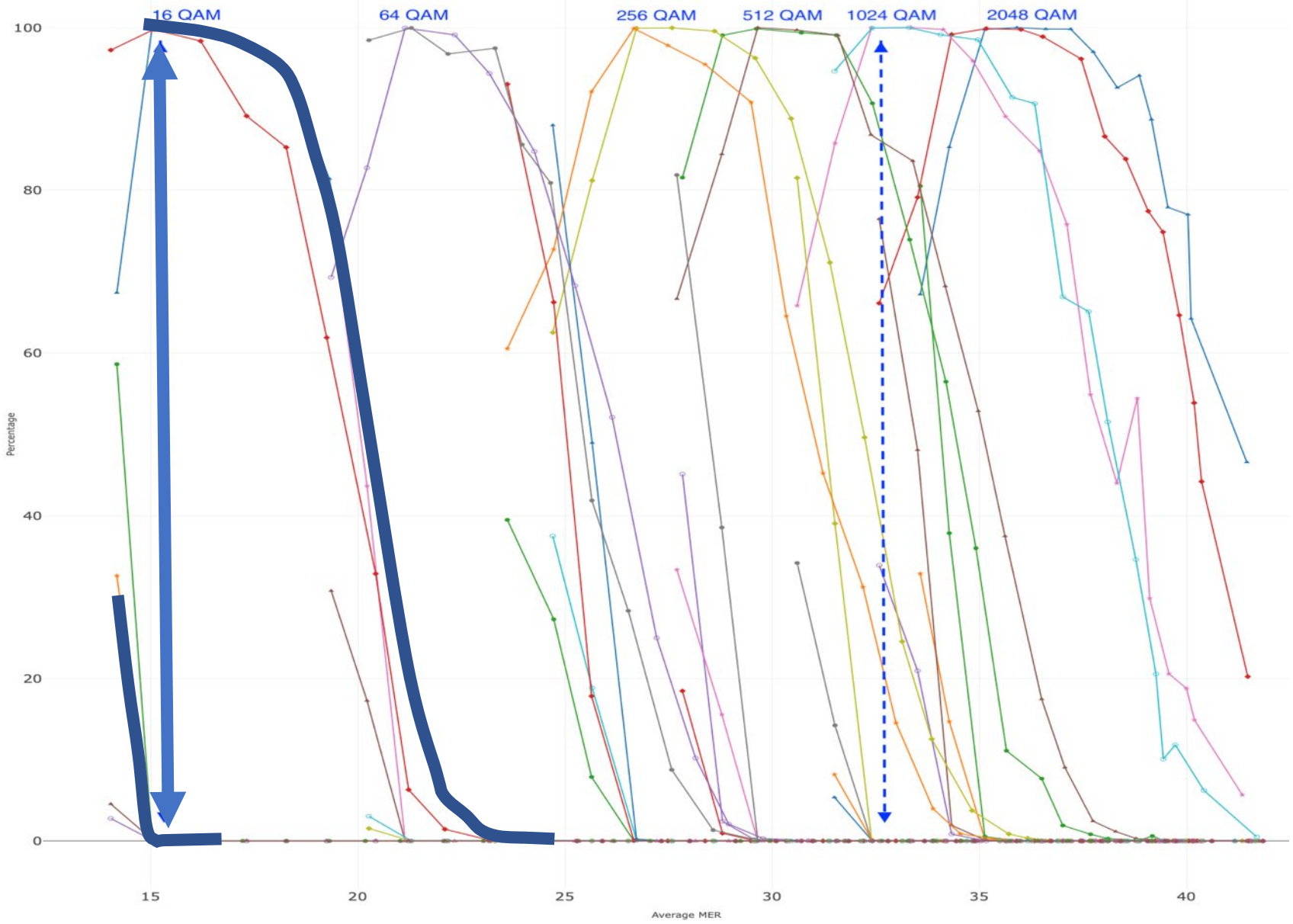
FEC & Modulation Orders

For each Mod Order

- As noise increases
  - Correctable CWs decrease
  - Uncorrectable increases after correctable hits 100%

Managing Profiles

- Get a PMA solution going



Cyclic Prefix (CP) & Roll-off Period (RP)

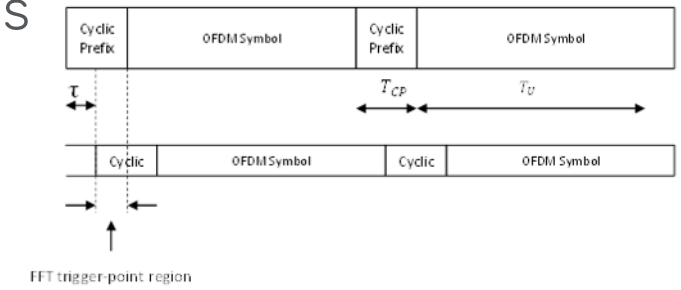
CP accommodates for

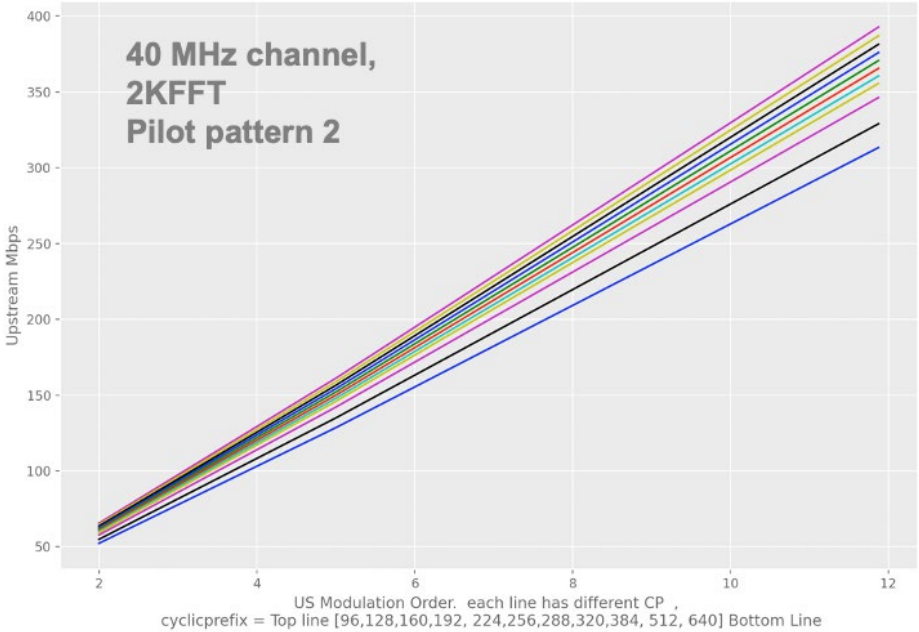
- Group delay (before the main tap)
- Longest Significant Echo (after the tap)

Roll-off period

- Embedded into the CP time

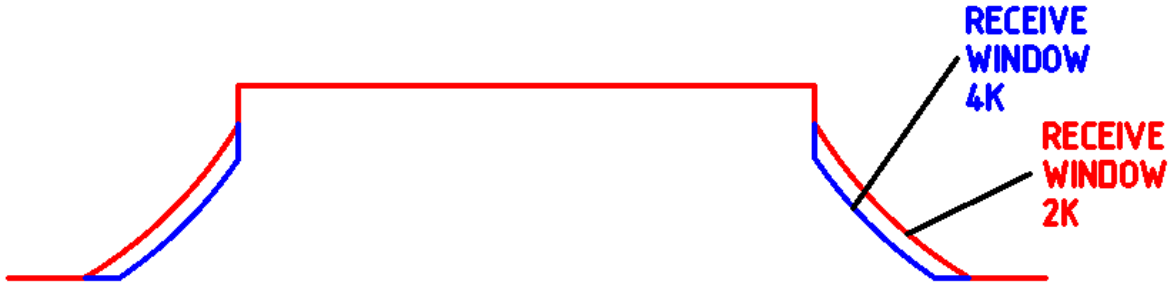
- CP should be longer than the longest echo…
  - Measure the echoes

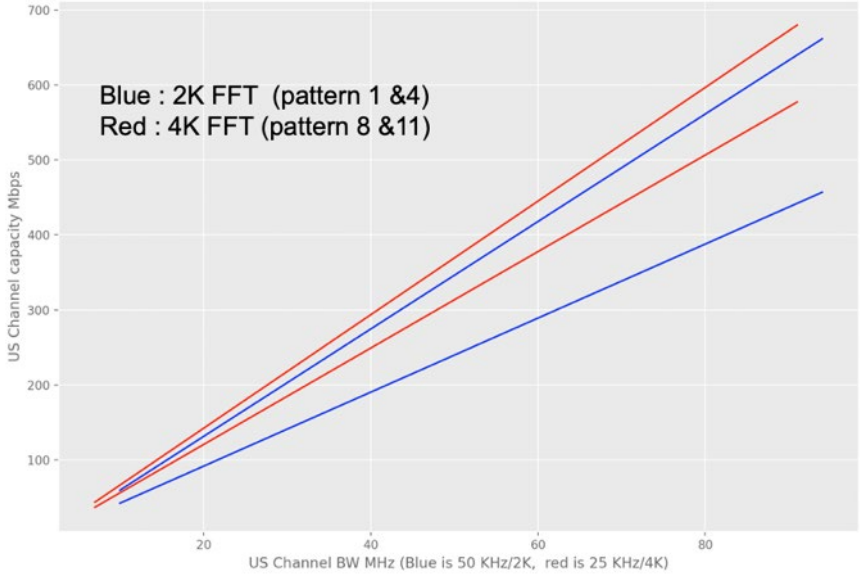




2k FFT(50 kHz,20μs) vs. 4k FFT (25 kHz,40μs)

- 4k (Pro): Less CP overhead
- 4k (Con) : More sensitive to phase noise (at CMTS/CM), at higher SNR levels
- 2k (Con) more vulnerable to interference in an adj band.
- Side band lobes: 2k is twice as susceptible because each sidelobe is twice as wide, relative to 4k
- 25 KHz Subcarrier spacing better than 50 KHz

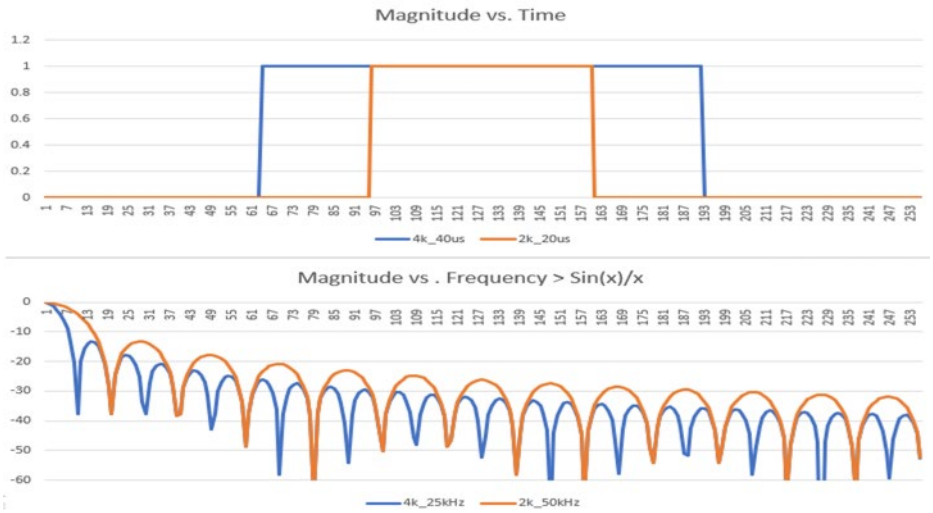


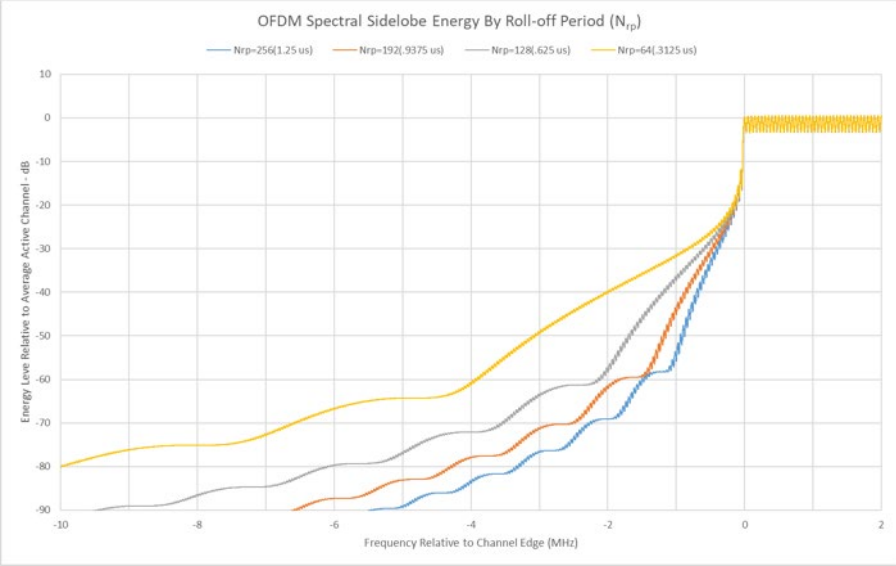


Upstream Interference Analysis

OFDMA protection depends on Receive Spectral Window and relative channel placement, and 2K vs 4K

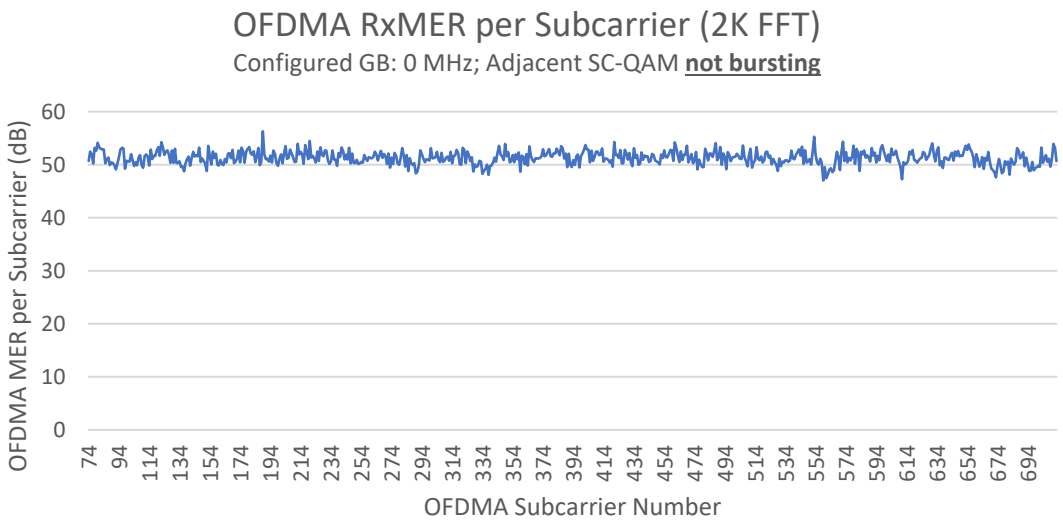
SC-QAM protection depends on OFDMA Roll-off period configuration and relative channel placement

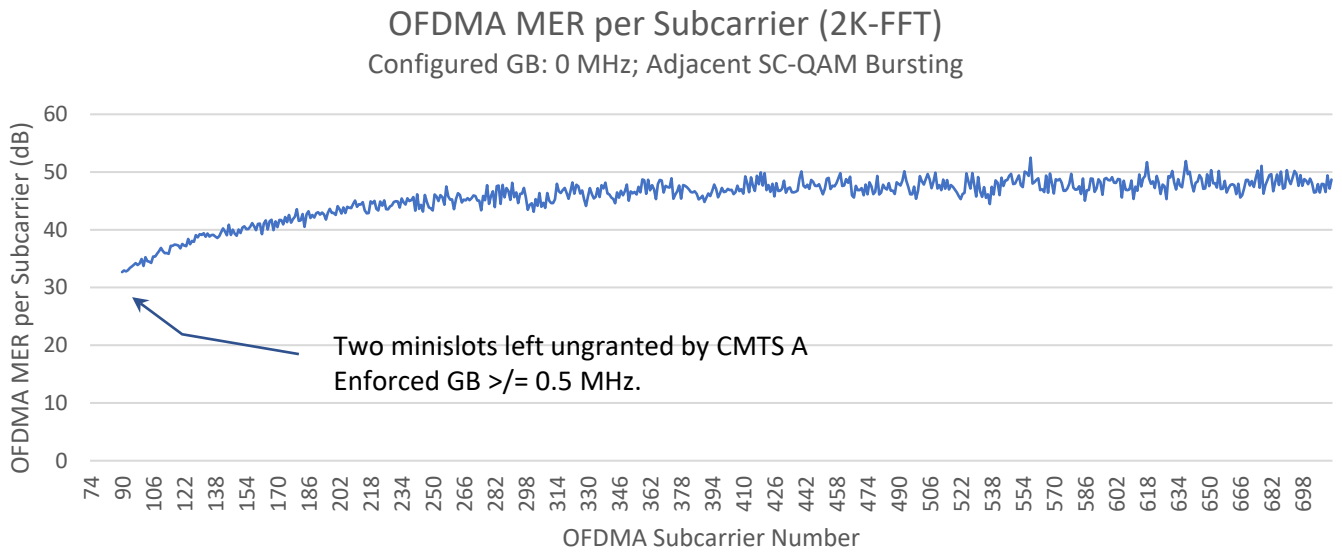


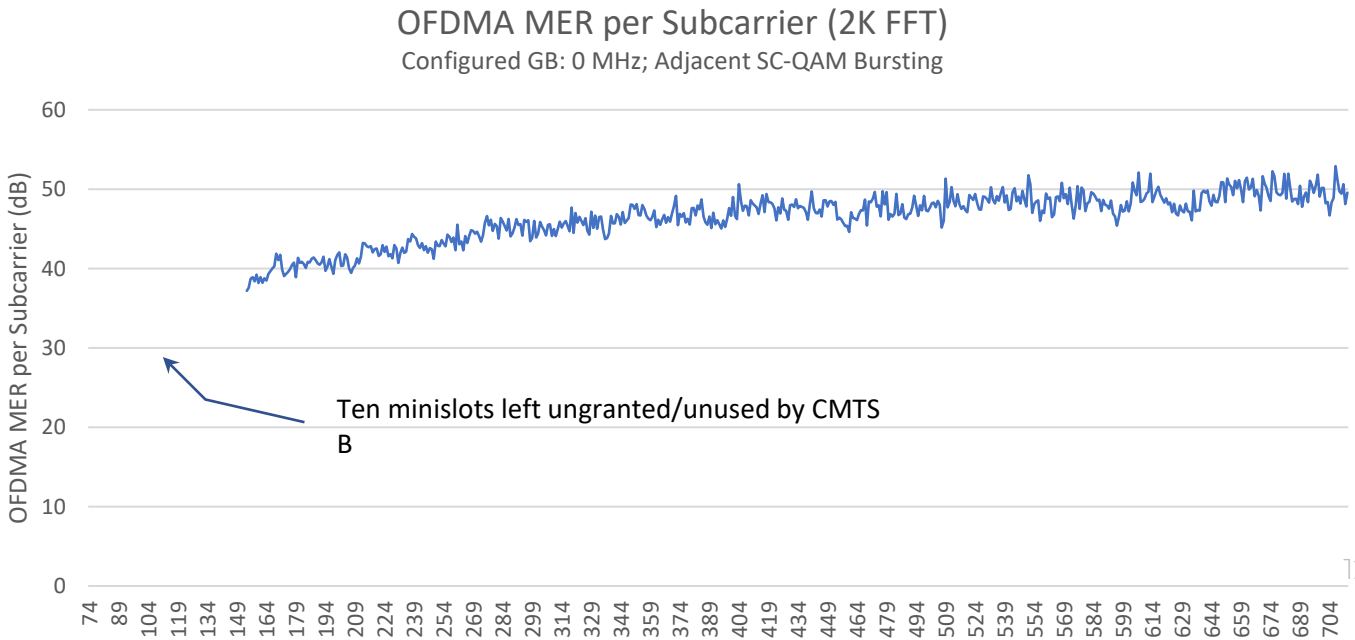


** Figure: MATLAB simulation data provided courtesy of Roger Fish & Thomas Kolze, Broadcom*

Guard Bands



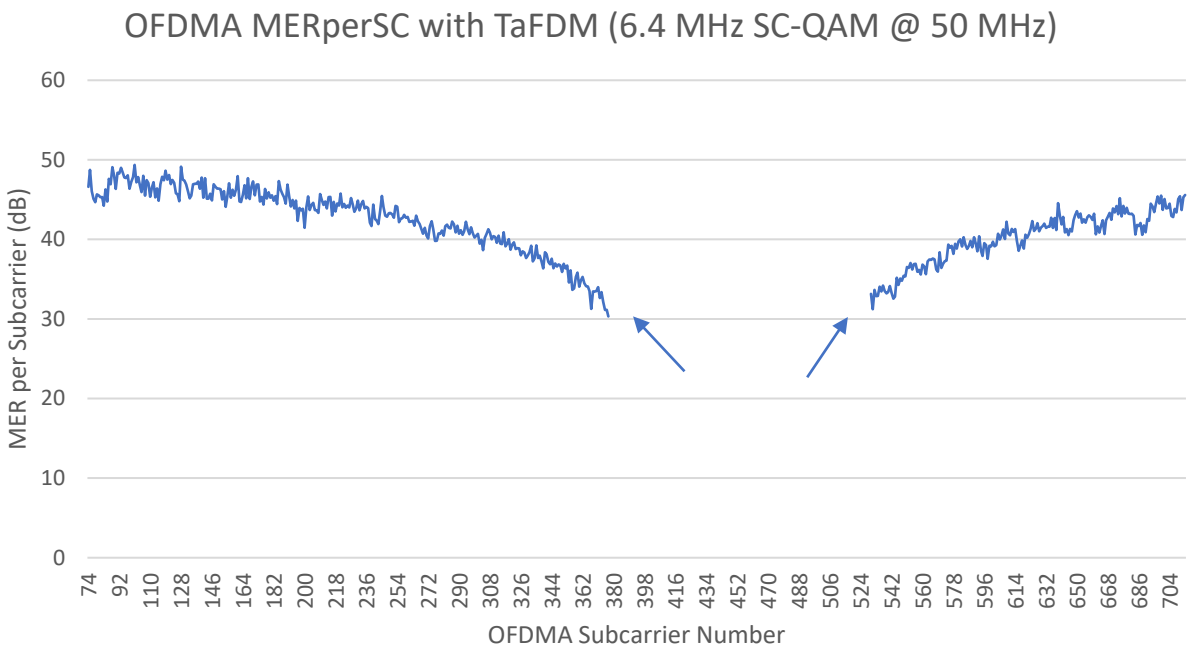


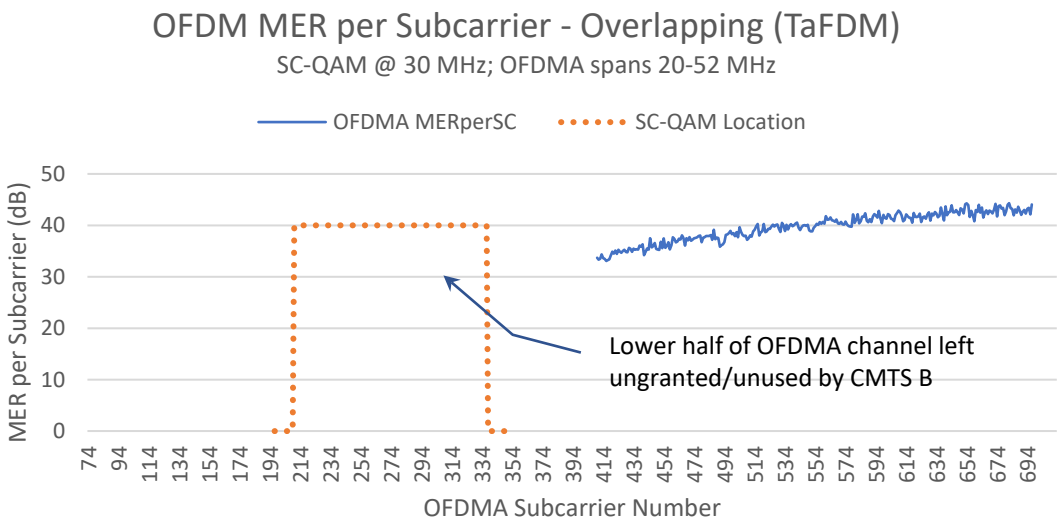


Add Guard Band if you have the spectrum

TaFDM

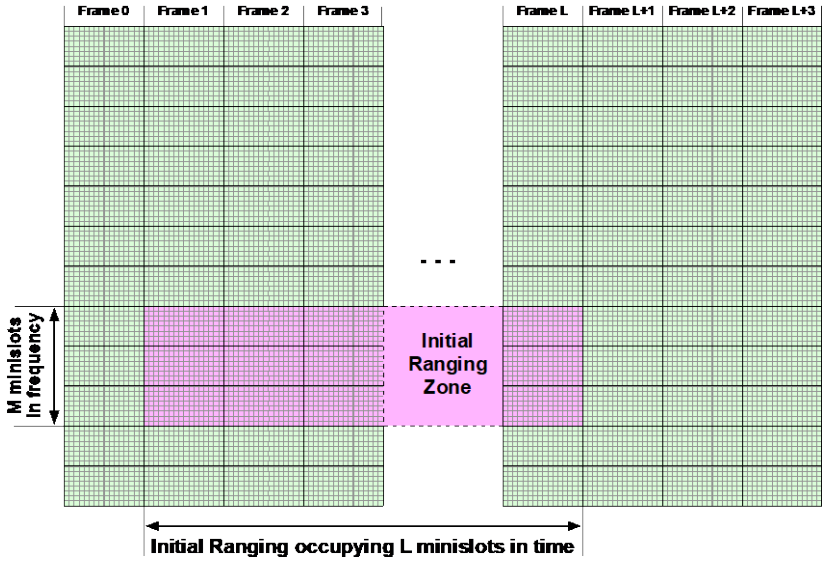
Location of overlap, CMTS rules, un-used minislots lowers efficiency





Multiple DOCSIS System Considerations

Location of the Ranging Zone



Contention vs dedicated

Piggybacking

Profile Management (IUC definition/changes)

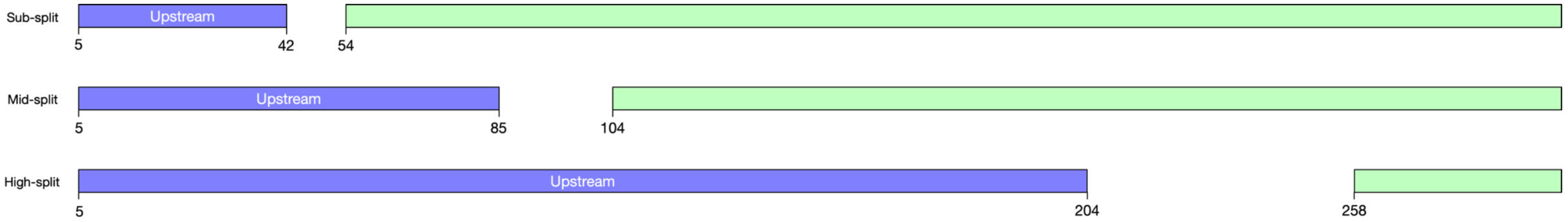
Channel conditions / PNM

US Partial Service algorithms

Service Flow config (e.g. Max Burst)

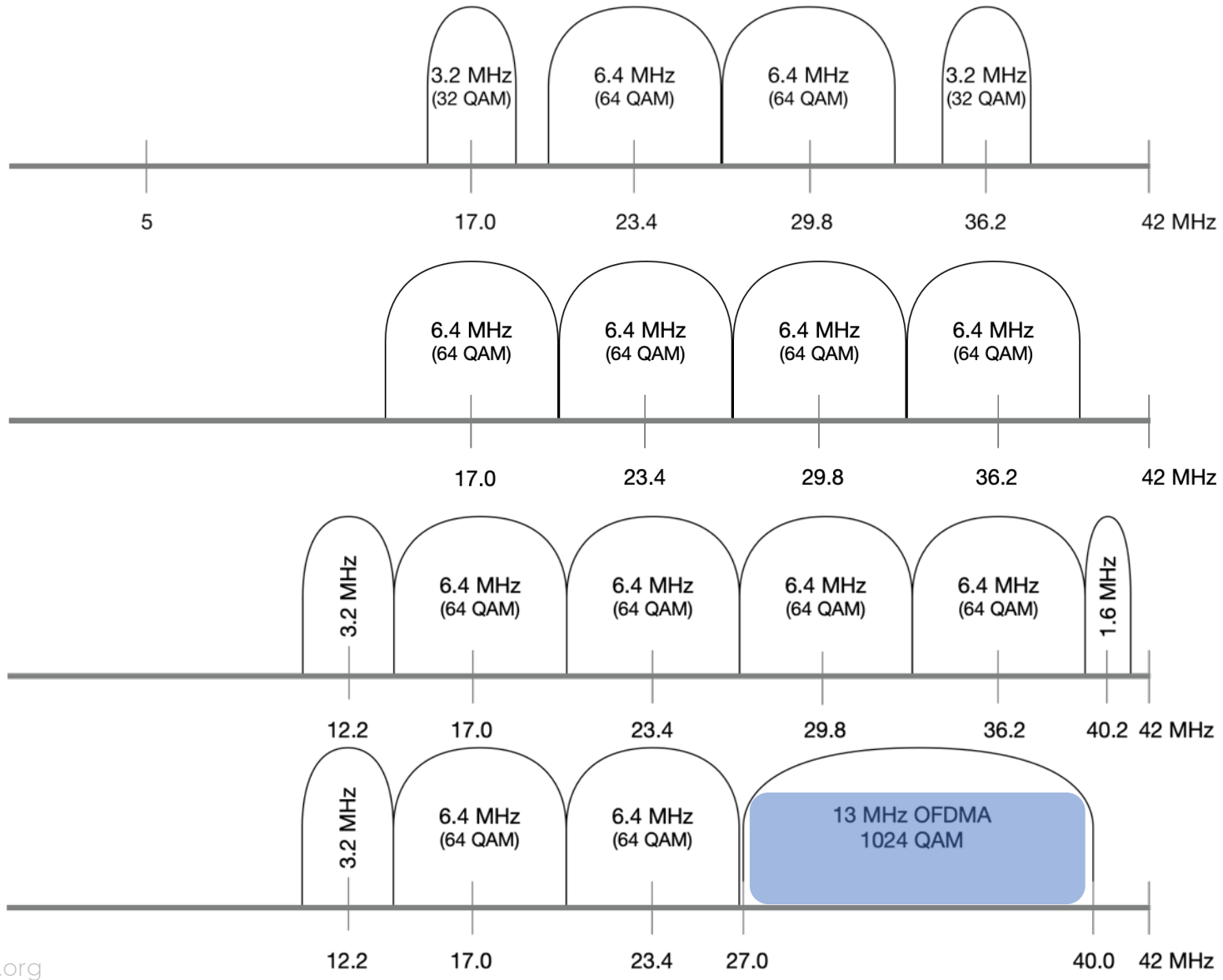
Upstream stability / processes

Upstream Split options



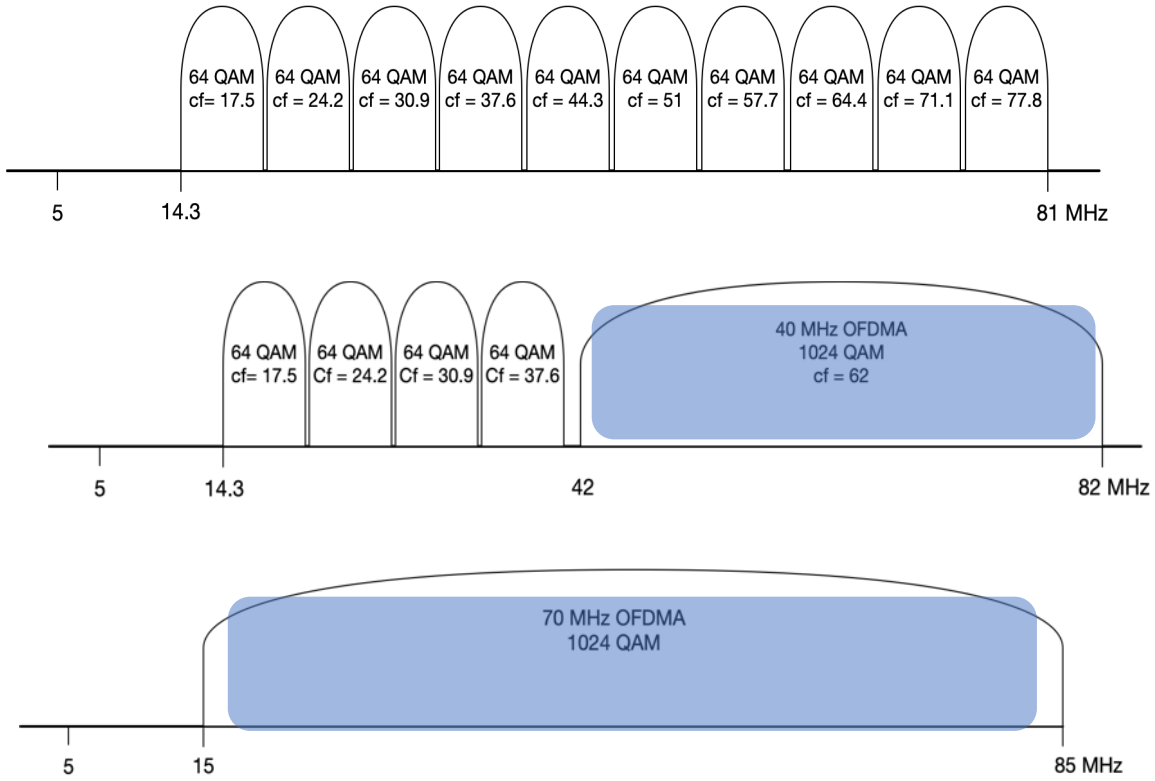
Low Split options

50 Mbps to ~160 Mbps



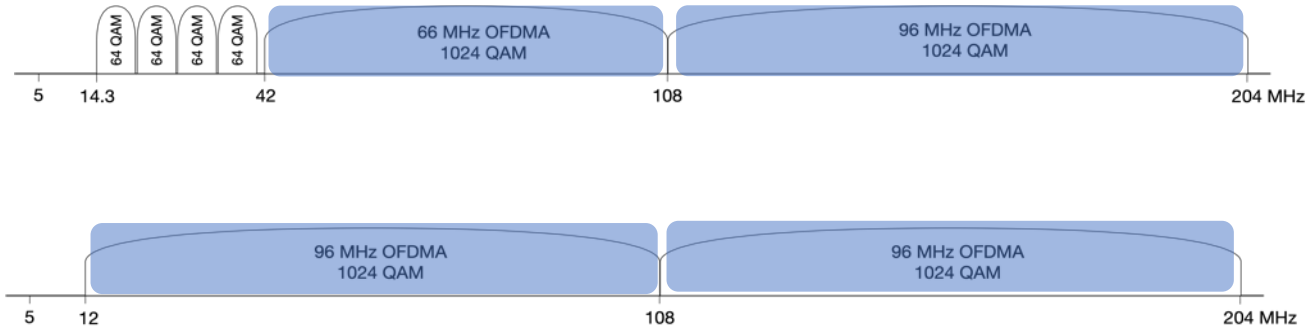
Mid Split

250 Mbps to ~525 Mbps



High Split

1.3 Gbps to ~1.7 Gbps



Mindful optimization of Upstream is needed

SC-QAM & OFDMA

- Channel location, Channel Parameters (frame size, CP/RP, 4k/2k FFT)
- Guard bands, Profiles, Adjacent Channel Interference, Ranging zone

More Spectrum

- Mid-split/high split with OFDMA for higher speeds

Please read the paper !

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Thank You!

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