Coax Resource Allocation & Tone Reordering

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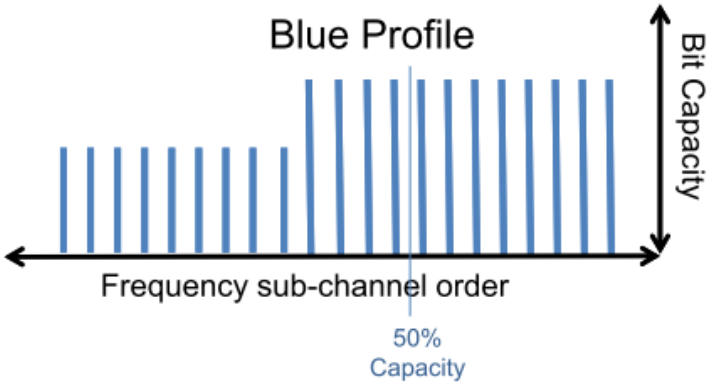
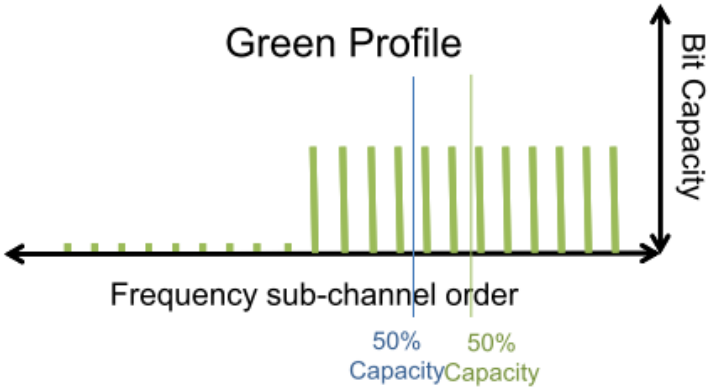
Problem with MMP/Capacity

- **There is no problem calculating Capacity when there is only one profile**
- **However with MMP a problem exists**
  - RB's in different profiles will not have the same capacity ratio
  - Burst Start time position will be different and may overlap in frequency
  - See illustration in [1]





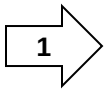
Tone Reordering

- **Tone Reordering – a type of Frequency interleaving**
  - Objective is to rearrange sub-carrier order so as to force the capacity of each Resource Block to be as close to the same as possible
  - Two Examples
    - **Example 1 uses a “high low” algorithm**
    - **Example 2 uses a “best average” algorithm**

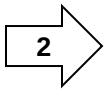
Tone Reordering example 1

- **An example algorithm**
  - Tones are reordered by alternating between low order tones and high order tones
    - **Additional improvements possible**

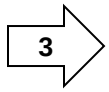
Origional Loading	
Orig	Loading
1	3
2	6
3	8
4	5
5	6
6	2
7	2
8	9
9	8
10	9



1. Sort by Loading	
Orig	Loading
6	2
7	2
1	3
4	5
2	6
5	6
3	8
9	8
8	9
10	9

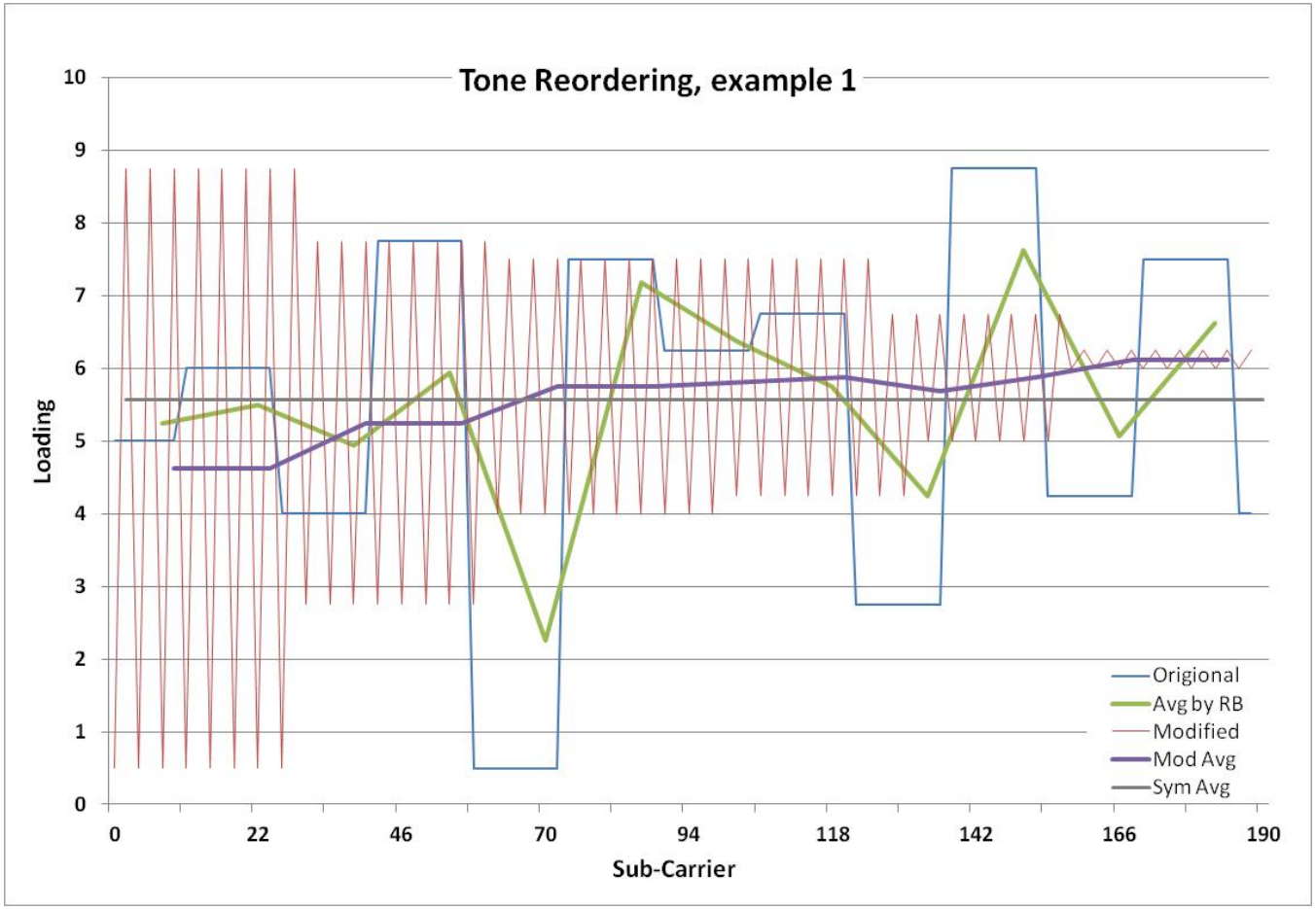


2. Reassign New Order	
New	Loading
1	2
3	2
5	3
7	5
9	6
10	6
8	8
6	8
4	9
2	9



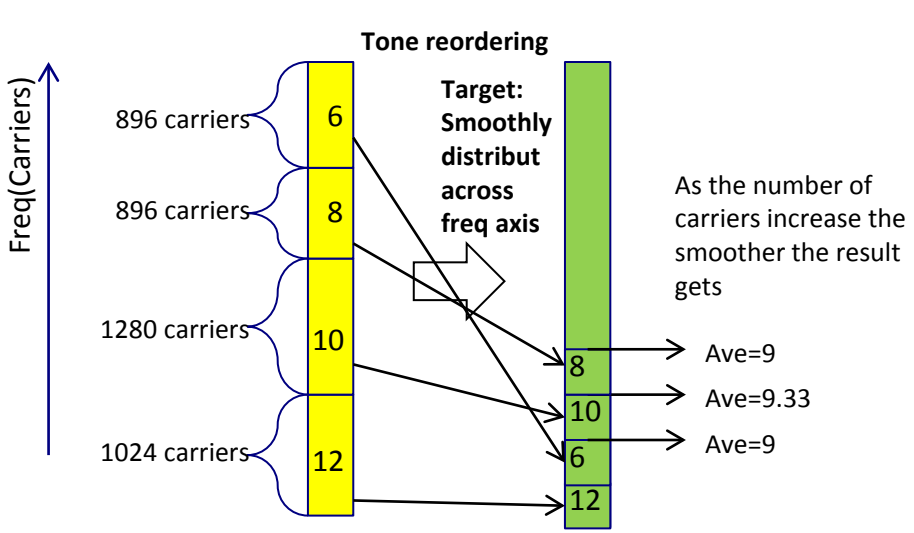
3. Sort by New Order	
New	Loading
1	2
2	9
3	2
4	9
5	3
6	8
7	5
8	8
9	6
10	6

Tone Reordering example 1

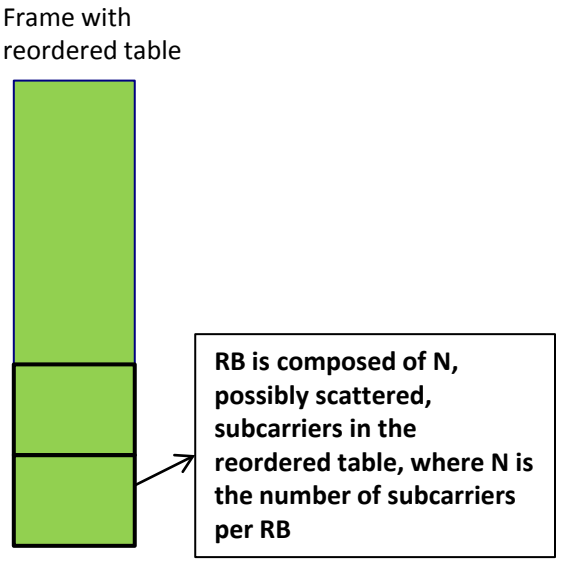


Tone Reordering example 2

- **Another example algorithm**
  - Tones are reordered so that the running average most closely approaches the average over the entire spectrum as possible
  - Objective is to make the bitloading distribution as smooth as posible over the entire frequency range



Assume total of 4096 subcarriers with an average loading of 9.1875



Tone Reordering example 2

- **After reordering, bitloading is smoothly distributed across frequency spectrum**
  - When you take a number of adjacent subcarriers (**M**) from the reordered table, they can be described with the equation:

    Cm = (C x M) / N

    Where: **Cm is the capacity of M subcarriers**

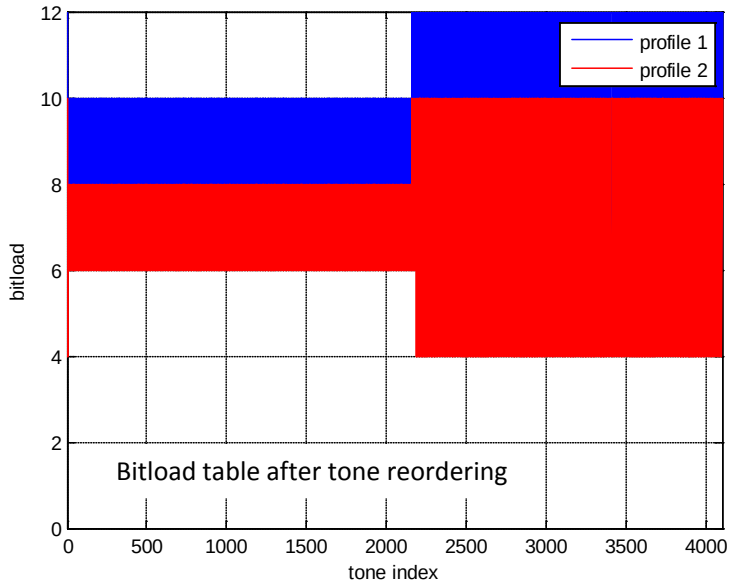
    C is the total capacity of the symbol

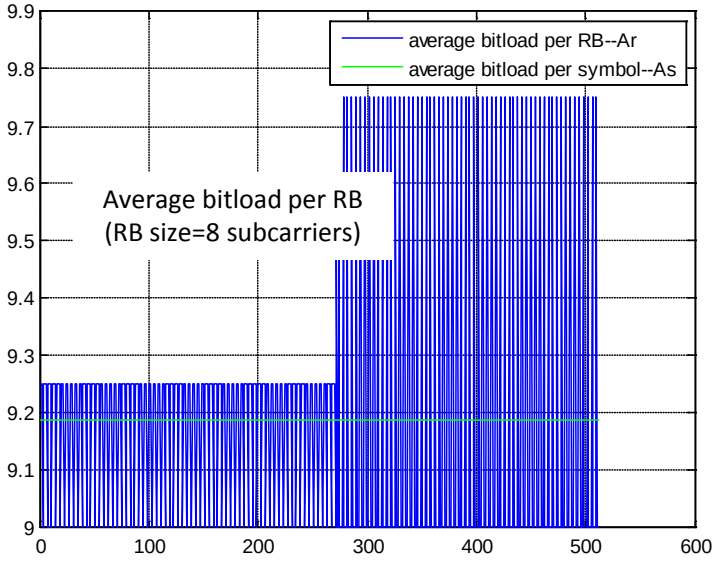
    N is the total number of available subcarriers in a symbol
  - The result is not completely flat but is very close, and as the number of subcarriers increases the result becomes flatter
    - **Need to round number of RB's up to ensure the transmission is ≥ the length (in TQ) in the GATE**

Tone Reordering example 2

Simulation results:

- **After reordering, the profile is smoothly distributed across frequencies**
  - Left diagram is the bit loading table of two profiles after reordering
  - Right diagram is the average bitload per RB after tone reordering (RB size is 8 subcarriers)
    - **Average bit loading per RB fluctuats around average bit loading per entire symbol, which means the error will not increase when RB number of allocation increased**

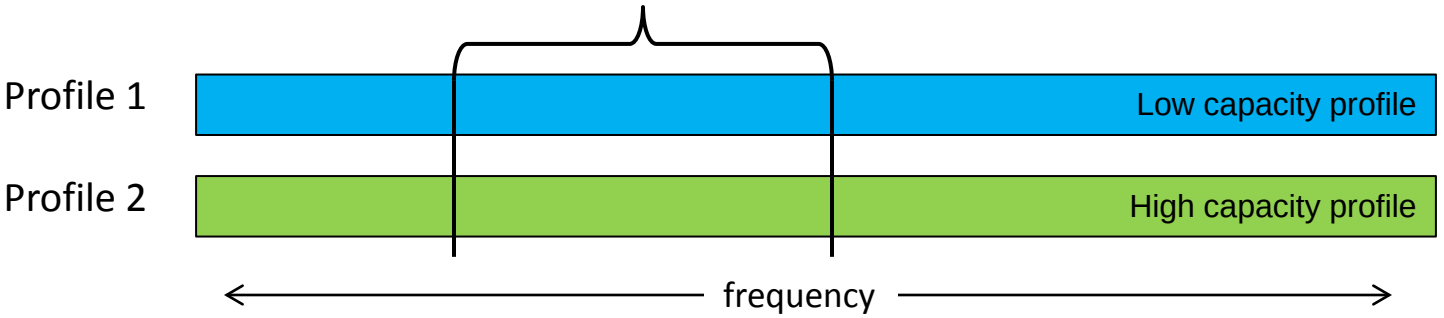




How reordering can solve the problem with MMP

- **Illustration for Multiple profiles**

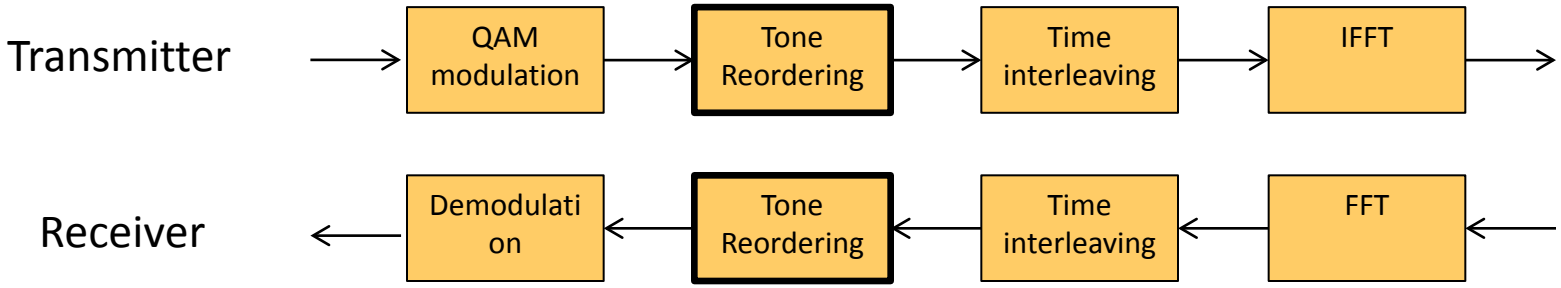
Pick up the same number of subcarriers/RBs in the same position, the ratio for different profiles can have the same equation **Cm = (C x M) / N**
Which means the same Gate message will indicate the same position for different profile, no conflict will happened



Profile 1&2 with the same reordering table

Impact to standard

- **Tone table (sub-carrier & bit loading) must be generated for reordering**
- **Additional function needed in PHY layer for transmit and receive**
  - RX process is inverse of TX process
  - Tone reordering is one kind of frequency interleaving
    - **objective is capacity leveling**
    - **may still need frequency interleaving for burst noise protection (not addressed here)**
  - QAM modulation and demodulation will be based on reordered table



Thank you

www.huawei.com

References

[1] - boyd_3bn_04a_0313.pdf