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Title	**Frequency precision in OFDM subchannelization**
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Abstract	**Frequency precision in OFDM subchannelization**
Purpose	Resolving ambiguity in PHY layer OFDM
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Frequency precision in OFDM subchannelization

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1 Statement of the problem

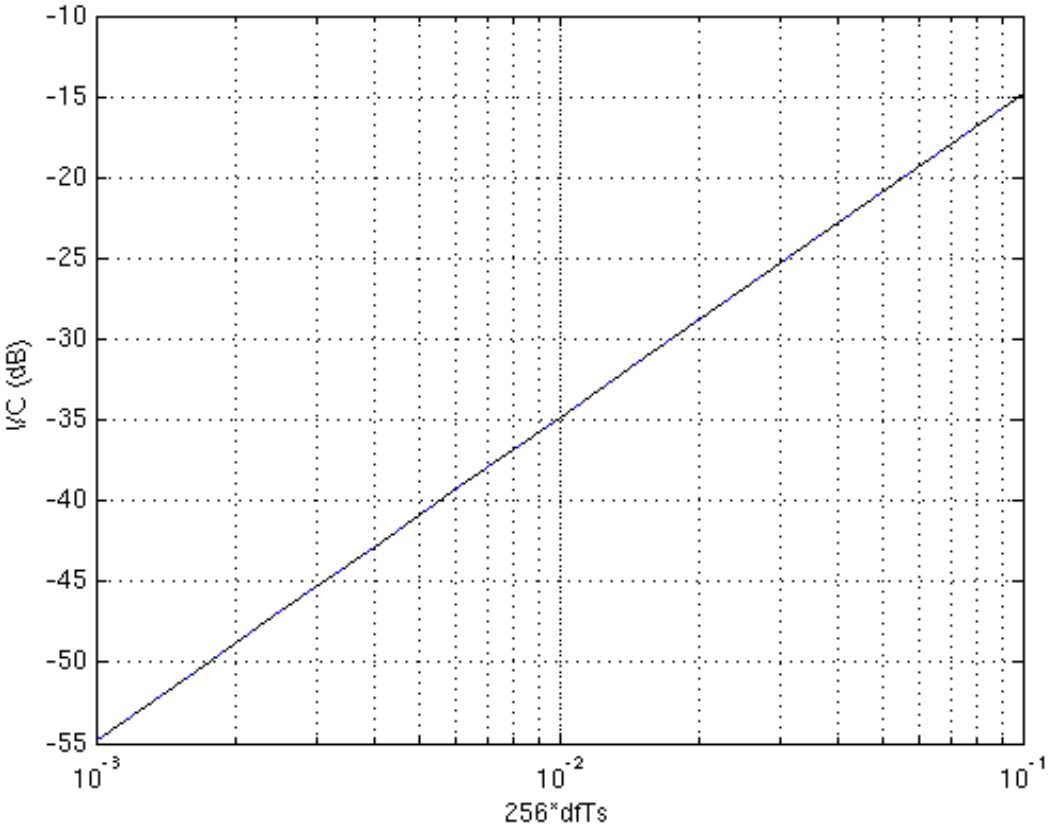
There is a need for better frequency precision in OFDM when doing UL Subchannelization.

2 Justification

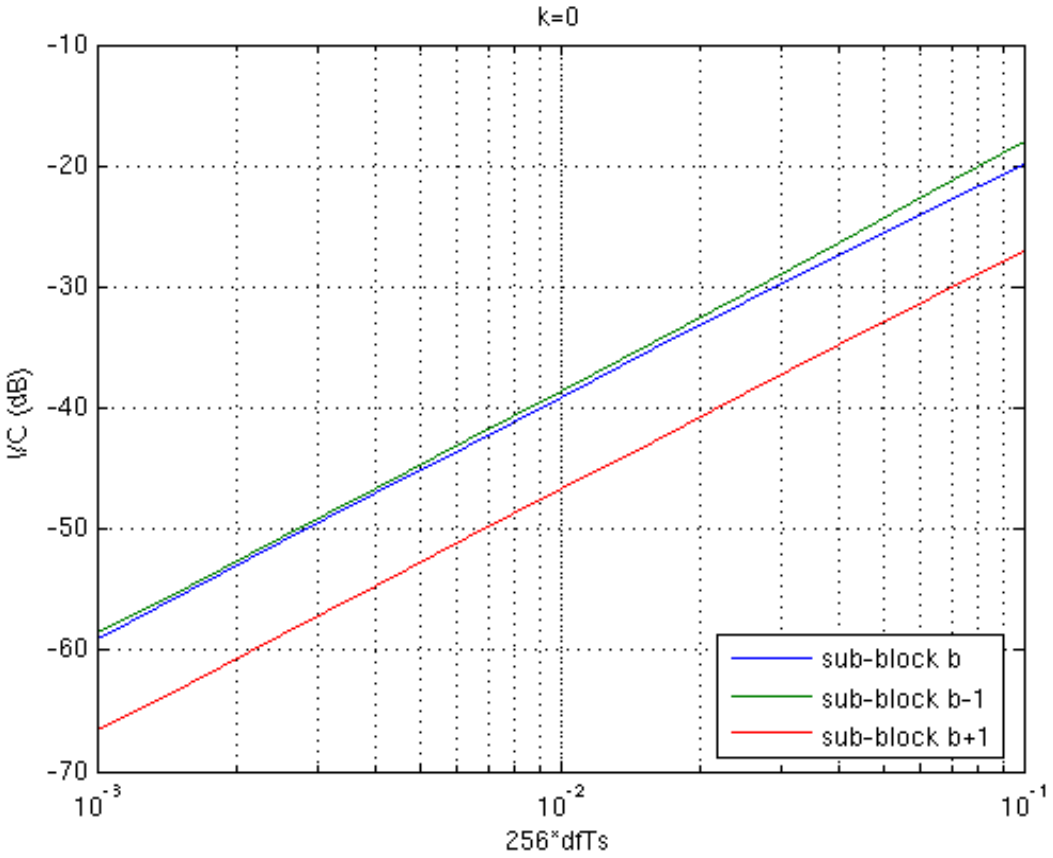
A classical calculation leads to the following formula for the level of C/I in an OFDM system with no subchannelization, depending on the frequency offset Δf:

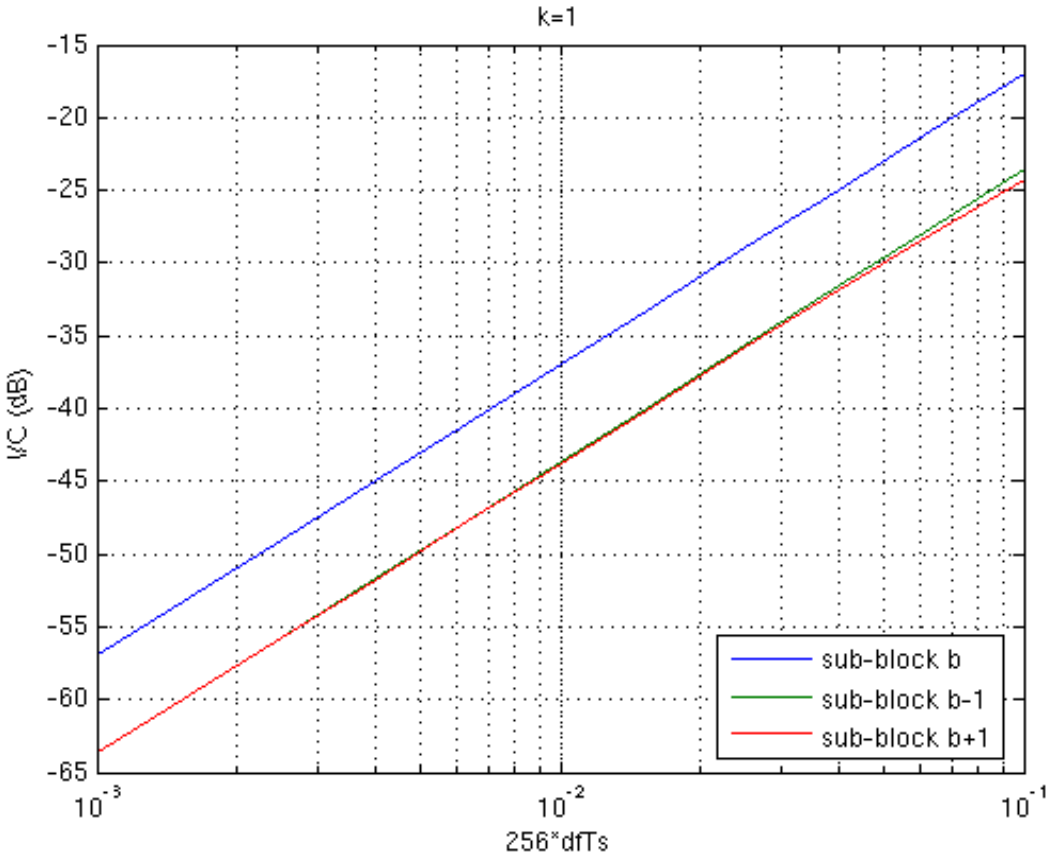
$$I_k(\Delta f) = \frac{\sin^2\left(256 \cdot \pi \cdot \Delta f\right)}{256^2 \cdot \sin^2\left(\pi \cdot \Delta f\right) - \sin^2\left(256 \cdot \pi \cdot \Delta f\right)}$$

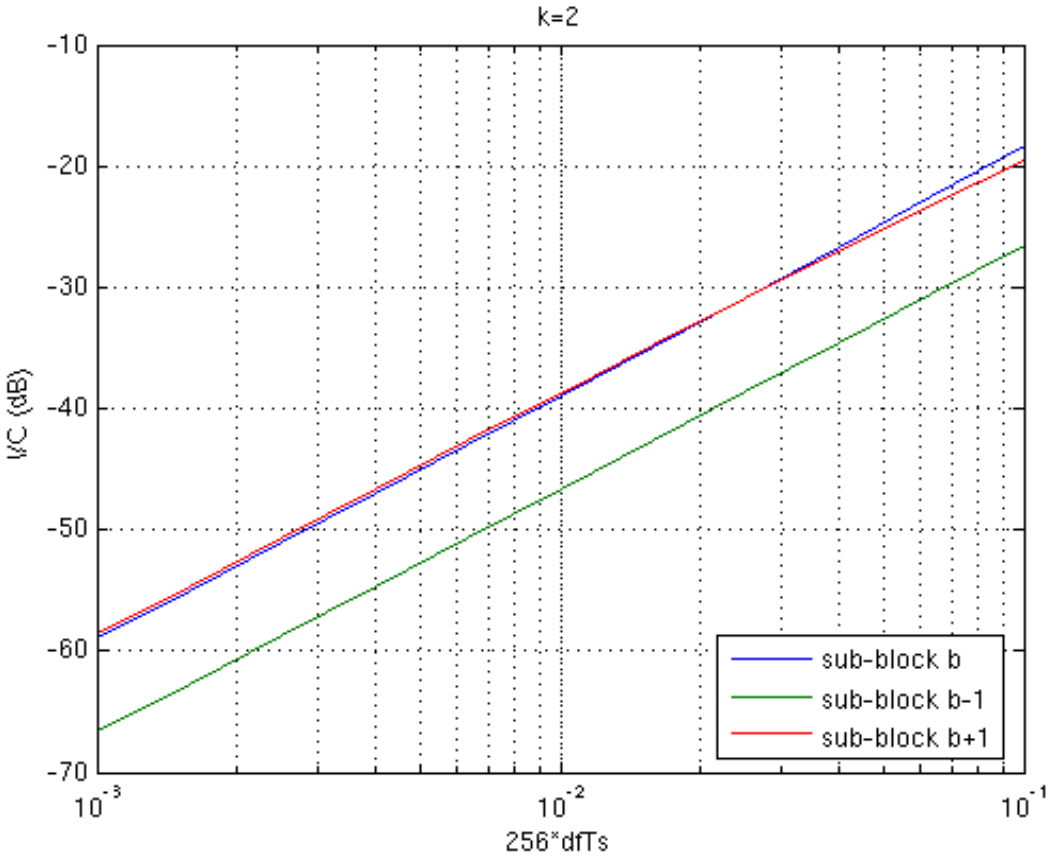
This is shown in the following graph



With Subchannelization, the situation is more complex, because different levels of interference are generated by each subchannel. Furthermore, there can be different levels of received PSD for different users, due to imperfect power control.
Subchannelization is made with blocks of 3 adjacent subcarriers. A first-order approximation is that interference for a given block *b* only originates from blocks *b-1* and *b+1*. Inside a block, let k be the index of the 3 subcarriers (*k=0,1,2*). The following graphs show the level of interference generated on each of these 3 subcarriers, by a given offset of blocks *b-1*, *b* and *b+1*:




k=1
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
I/C (dB)
10^-3
10^-2
10^-1
256*dfTs
sub-block b
sub-block b-1
sub-block b+1



As can be seen, the dominating term for the middle carrier of a block is self-interference from its own block. But for the edge subcarriers, there is roughly the same level of interference from its own block than the adjacent block. In the case this adjacent block arrives at a higher level of PSD because of imperfect power control, then the resulting C/I will be from this adjacent block. Based on the previous figures, this leads to the following table:

Δf (% subcarrier spacing)	C/I (dB) same PSD	C/I (dB) +6 dB PSD	C/I (dB) +12 dB PSD
2	33	27	21
1	39	33	27
0.5	45	39	33
0.25	51	45	39

A level of 33 dB is required to properly operate in 64QAM with very little degradation. Considering the possibility of entering in fadings of up to 10 dB, choosing 0.5% seems to be an appropriate requirement.

3 Specific text changes

Add section 8.3.12, page 70

Modify 2nd paragraph:

“At the SS, both the transmitted center frequency and the symbol clock frequency shall be synchronized and locked to the BS with a tolerance of maximum 2% of the subcarrier spacing. When using Subchannelization, the tolerance shall be 0.5% of subcarrier spacing.”