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Re:	Contribution supporting Sponsor ballot
Abstract	Frequency reuse factor of 1 and non-one frequency reuse factor support at the same time
Purpose	Adoption of suggested changes into P802.16e/D3
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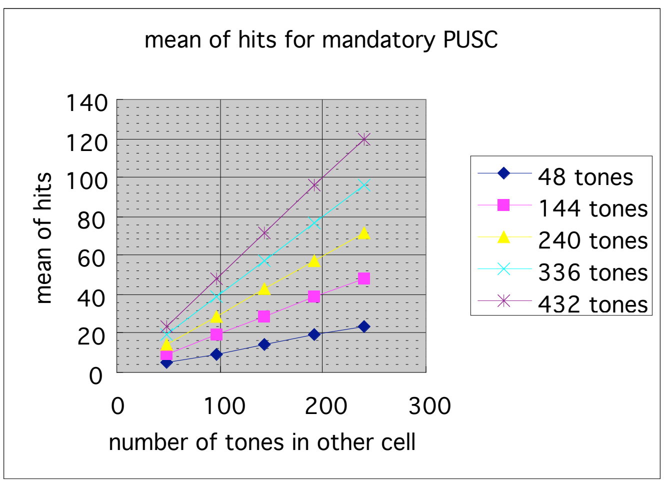
Problem definition

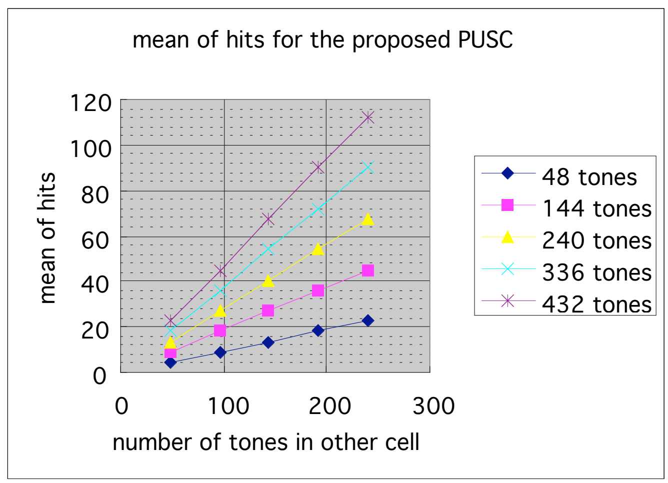
~~In the current IEEE 802.16 REVd/D5, PUSC, FUSC, optional FUSC, and AMC permutation can be supported in a single frame by using Zone_Switch_IE(). All the permutation methods are supported in a full usage manner, but only PUSC permutation is supported in a partial usage manner. IEEE 802.16e/D3 also specifies using AMC permutation in a partial~~

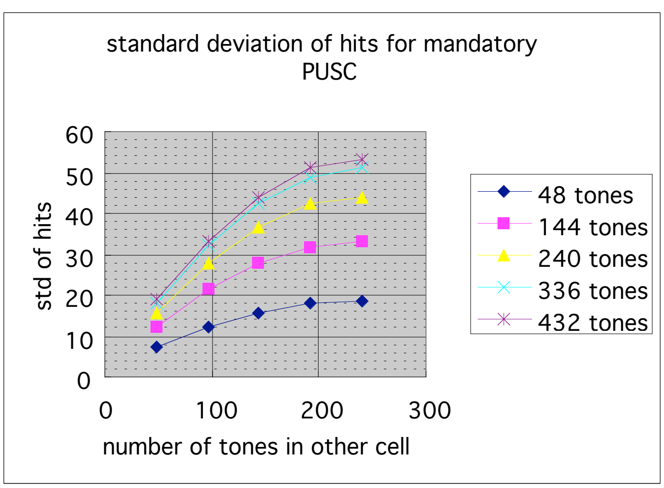
~~usage manner. In this contribution, several permutation schemes for partial usage are introduced.~~

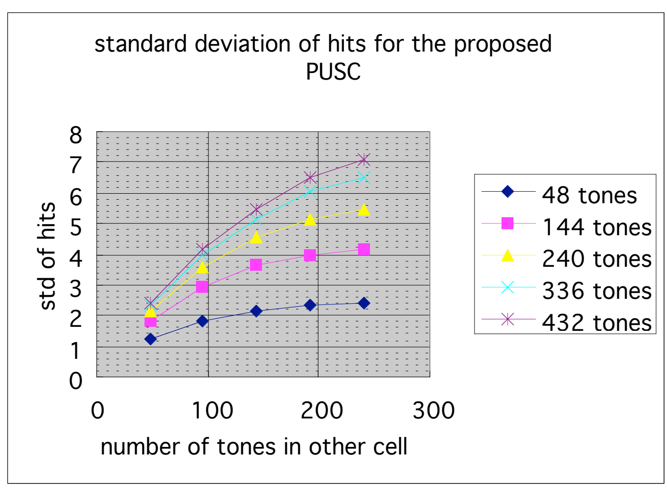
In the current downlink PUSC permutation specified in P802.16 REVd/D5, there are 6 major groups consisting of 24 or 16 clusters that are scattered over whole frequency band. Since clusters in each segment are not located contiguously, channel estimation should be done within each cluster. That is, pilots in contiguous clusters cannot be used for channel estimation, which may degrade channel estimation performance. Also, pilots are spaced 4 subcarriers apart over 2 symbols, which may be insufficient for highly dispersive multi-path channels. In this contribution, new PUSC permutation method is proposed. The proposed PUSC permutation uses existing permutation formula used for optional downlink FUSC permutation in P802.16 REVd/D5. In the proposed PUSC permutation, effective pilot spacing is 3 subcarriers as is the case in optional downlink FUSC permutation. Also, in the proposed PUSC permutation the basic element constructing a segment is 36 contiguous subcarriers and hence all the pilots within these 36 subcarriers can be used for channel estimation, which may give better channel estimation performance.

One more thing that has to be noted for the proposed PUSC permutation is hit distribution. Hit means the collision of subcarriers between subchannels in different cells. On the other hand, hit means the interference from other cell. Mean of hits can be regarded as average interference from other cell and the variance of hits is interference variation. Large variance of hits implies that there can be some SSs who experience severe interference compared to other SSs in the same cell, which is not desirable. It will be better that every SSs in a cell experience the same interference level as possible as one can. In the proposed permutation, the variance of hits is very small compared to that of the current PUSC permutation. The following figures show the standard deviation of hits for the current PUSC and the proposed PUSC. It is assumed that there are two cells, one cell is a serving cell and the other is just other cell. In order to obtain each point in each curve, cell ID for serving cell and other cell is randomly selected, subchannels in the serving cell and the other cell are randomly selected and the hits between selected subchannels are counted. This procedure repeats 100000 times. The label of each curve is the number of tones per symbol used in serving cell. As one can see in the figures, there is no significant difference in the mean of hits. But as for the standard deviation of hits two PUSC permutations give quite different results.









Possible permutation schemes

1. Type I

The current FUSC permutations can be candidates. In order for those FUSC permutations to be used in a partial usage manner some fraction of total symbols are partitioned into segments which can be called "PUSC zones" and each PUSC zone is used exclusively in each sector or each BS. Figure 1 shows an example of basic downlink or uplink structure when the above scheme is applied.

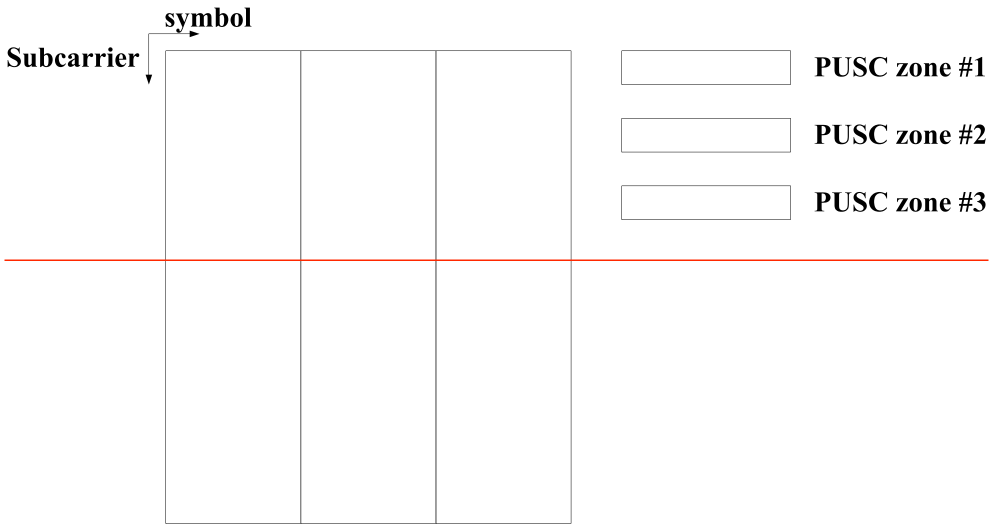


Figure 1 structure of downlink/uplink when type I scheme is applied

2. Type III

The method 1 divides the resources through time axis to provide partial usage mannered permutation zone. So called "PUSC zones" can be provided by dividing the resource through frequency axis which is the case in the currently supported schemes in 802.16 REVd/D5 and 802.16e/D3. The basic concept is depicted in Figure 2. In each PUSC zone, scattered carrier permutation scheme will be applied in order to provide frequency diversity.

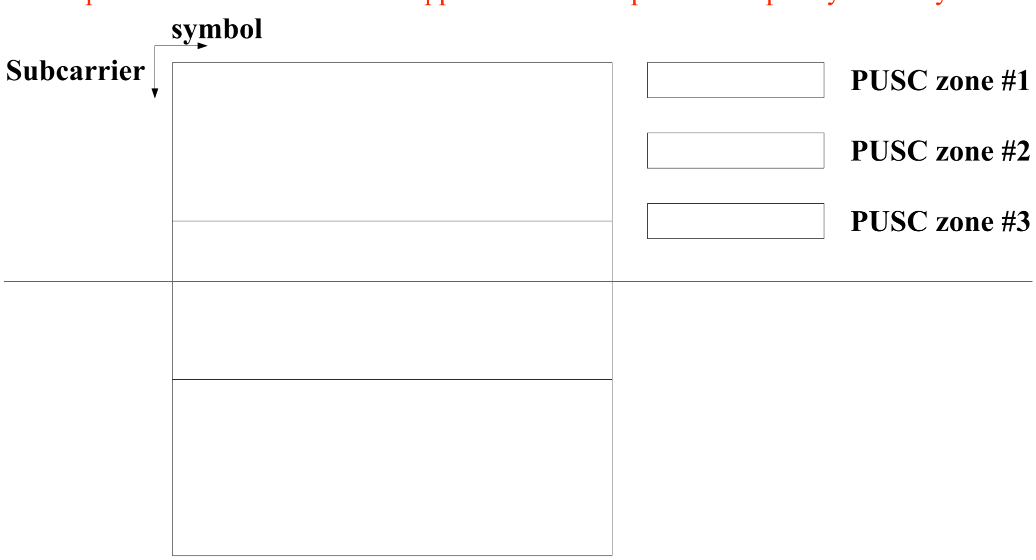
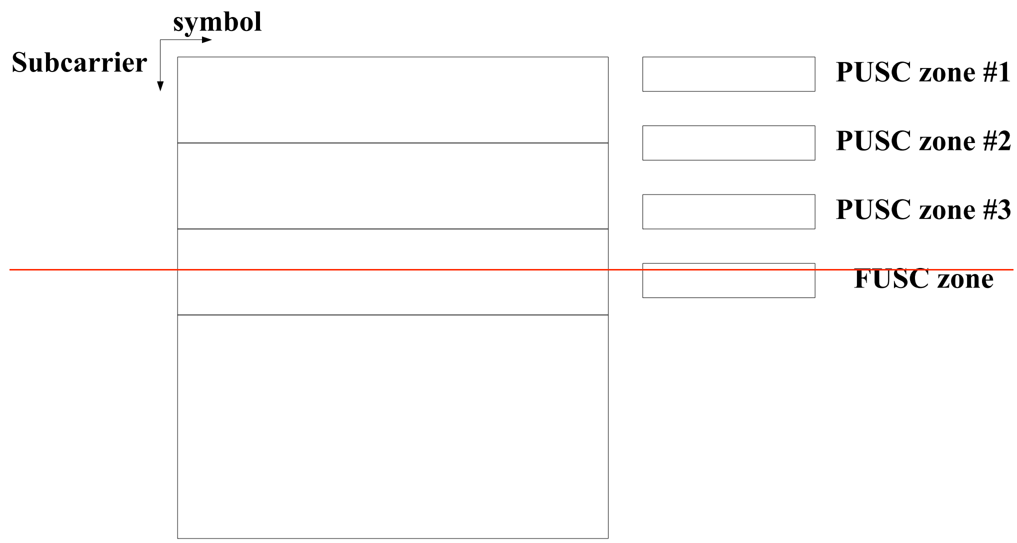


Figure 2 Basic structure of downlink/uplink when type II scheme is applied

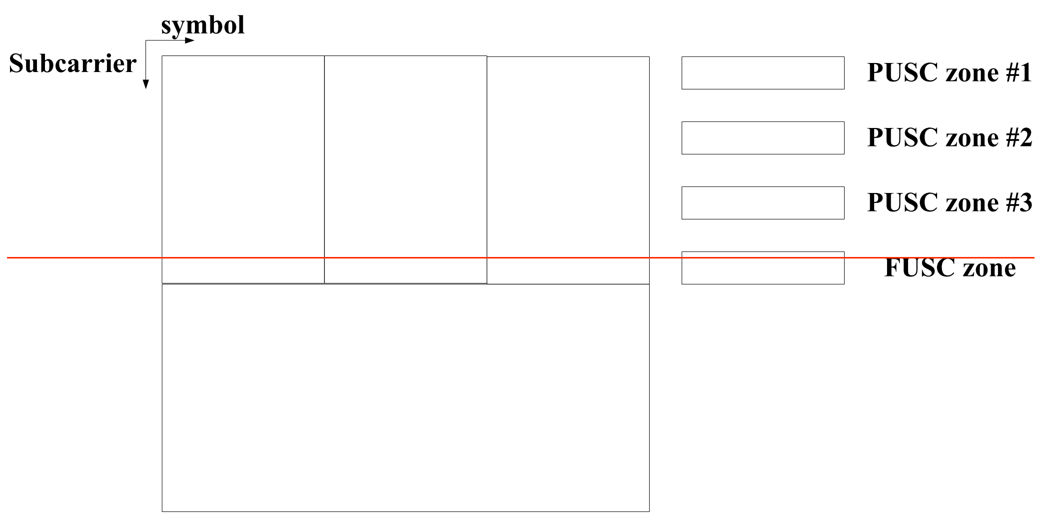
3. Type III

One more possibility is the mixed structure of method 1 and 2. That is, "PUSC zones" are constructed by dividing

~~resources through time and frequency axis. This scheme can give more flexibility to resource allocation.~~



~~**(a) mixed structure : type III-A**~~



~~**(b) mixed structure : Type III-B**~~

~~**Figure 3 Basic structure of downlink/uplink when a type III scheme is applied**~~

Suggested change to the standard

~~**Type I**~~

~~Add the following section :~~

~~**8.4.6.1.2.4 Additional optional symbol structure for PUSC type I**~~

~~Subcarrier allocation for PUSC type I is depicted in Figure 1. Each PUSC zone is allocated a disjoint set of symbols. In each PUSC zone, Subcarrier allocation is the same as optional FUSC in section 8.4.6.1.2.3 and the permutation formula in section 8.4.6.1.2.3.1 shall be used.~~

~~**8.4.6.2.7 Subcarrier allocation in the uplink for optional PUSC type I**~~

~~Subcarrier allocation for PUSC type I is depicted in Figure 1. Each PUSC zone is allocated a disjoint set of symbols. In each PUSC zone, Subcarrier allocation is the same as optional PUSC in section 8.4.6.2.5 and the permutation formula in section 8.4.6.2.5.2 shall be used.~~

Type II

Add the following section :

8.4.6.1.2.4~~5~~ Additional optional symbol structure for PUSC type II

8.4.6.1.2.4~~5~~.1 Subcarrier allocation in the downlink for PUSC type II

Subcarrier allocation for PUSC type II is depicted in Figure 4. A bunch of 9 contiguous subcarriers containing 1 pilot carrier and 8 data carriers is called a bin and 4 consecutive bins are called a band. Those bands are divided into three segments each of which is assigned to a PUSC zone.

Table 1 2048 FFT downlink subcarrier allocation for PUSC type II

parameters	value	comments
Number of DC Subcarriers	1	
Number of Guard Subcarriers, Left	160	
Number of Guard Subcarriers, Right	159	
Number of Used Subcarriers(N_{used}) (including all possible allocated pilots and the DC carrier)	1729	
Number of Pilot Subcarriers	192	
Pilot subcarrier index	9k+3m+1, for k=0,…, 191 and m=[symbol index]mod3	Symbol of index 0 is the first symbol of a frame
Number of Data Subcarriers	1536	Data subcarriers are reordered and indexed as 0 ~ 1535
Number of Data Subcarriers for a PUSC zone	512	PUSC zone #0~~1~~ : band index 3k PUSC zone #1~~2~~ : band index 3k+1 PUSC zone #2~~3~~ : band index 3k+2 k = 0,1,…15

Table 2 1024 FFT downlink subcarrier allocation for PUSC type II

parameters	value	comments
Number of DC Subcarriers	1	
Number of Guard Subcarriers, Left	80	
Number of Guard Subcarriers, Right	79	
Number of Used Subcarriers(Nused) (including all possible allocated pilots and the DC carrier)	865	
Number of Pilot Subcarriers	96	
Pilot subcarrier index	9k+3m+1, for k=0,…, 95 and m=[symbol index]mod3	Symbol of index 0 is the first symbol of a frame

Number of Data Subcarriers	768	Data subcarriers are reordered and indexed as 0 ~ 767
Number of Data Subcarriers for a PUSC zone	256	PUSC zone #0~~1~~ : band index 3k PUSC zone #1~~2~~ : band index 3k+1 PUSC zone #2~~3~~ : band index 3k+2 k = 0,1,…7

Table 3 512 FFT downlink subcarrier allocation for PUSC type II

parameters	value	comments
Number of DC Subcarriers	1	
Number of Guard Subcarriers, Left	40	
Number of Guard Subcarriers, Right	39	
Number of Used Subcarriers(Nused) (including all possible allocated pilots and the DC carrier)	433	
Number of Pilot Subcarriers	48	
Pilot subcarrier index	9k+3m+1, for k=0,…, 47 and m=[symbol index]mod3	Symbol of index 0 is the first symbol of a frame
Number of Data Subcarriers	384	Data subcarriers are reordered and indexed as 0 ~ 383
Number of Data Subcarriers for a PUSC zone	128	PUSC zone #0 : band index 3k PUSC zone #1 : band index 3k+1 PUSC zone #2 : band index 3k+2 k = 0,1,…3

8.4.6.1.2.4~~5~~.2 Downlink subchannels subcarrier allocation

For PUSC type II operation, total bands are partitioned into 3 segments and subchannel subcarrier allocation is done in each segment. The partition into 3 segments is shown in Figure 4. To allocate the diversity subchannels, data tones in 3 consecutive symbols in a segment are partitioned into 48 groups of contiguous data subcarriers. Each subchannel consists of one subcarrier from each of these groups. The exact partitioning into subchannels is according to the permutation formula in section 8.4.6.1.2.3.1. If FFT size is 512, then N_s is 8. If FFT size is 1024, then N_s is 16. If FFT size is 2048, then N_s is 32. The basic permutation sequences P_1 and P_2 are shown in Table 309a. The enumeration of the subcarriers in a segment within three symbols starts from the lowest numbered data subcarrier of the first symbol in a segment and goes to the next carriers. If it reaches the last carrier in the symbol in the segment, it goes to the lowest data carrier of the next symbol and so on.

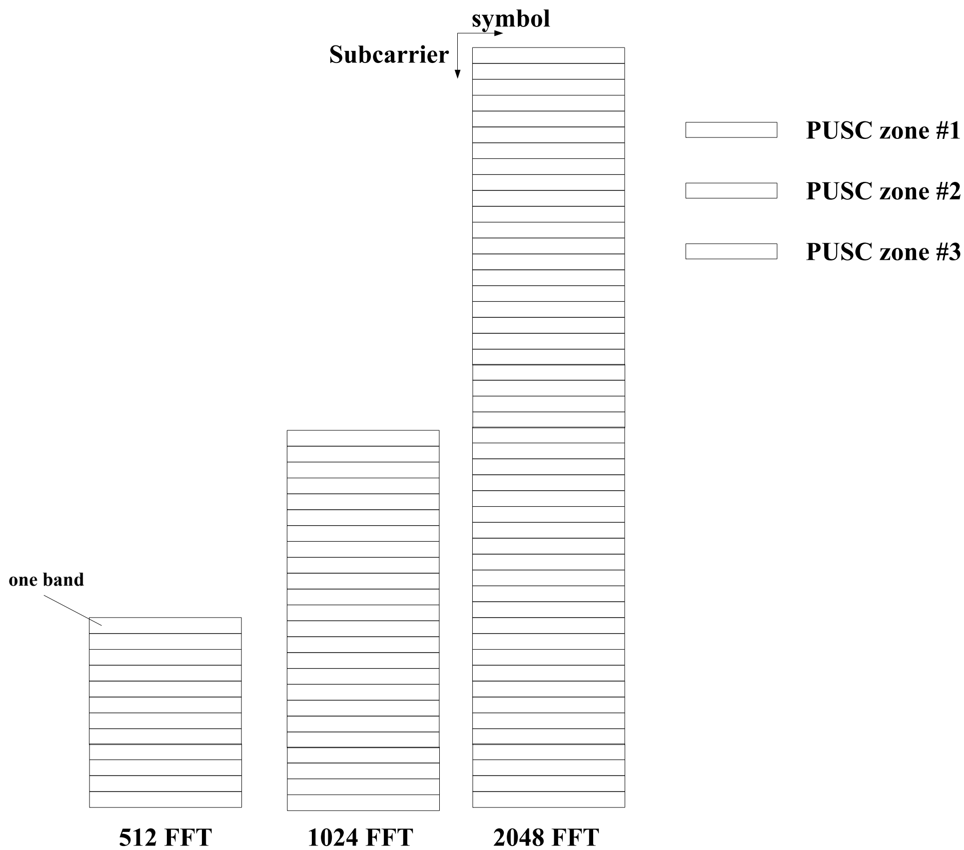


Figure 4 aaa Subcarrier allocation for PUSC type II

~~**8.4.6.2.8 Subcarrier allocation in the uplink for optional PUSC type II**~~

~~For optional PUSC type II in the uplink, subcarrier allocation is the same as the case for optional PUSC type II in the downlink in section 8.4.6.1.2.5.1 Subcarrier allocation in the downlink for PUSC type II. Subchannels subcarrier allocation is done in each segment which consists of L bands in according to FFT size as shown in Figure 4. There are M tiles in a segment and those tiles are partitioned into 6 groups each of which contains Ns contiguous tiles within the segment. Each subchannel consists of 6 tiles chosen from different groups. Thus there are Ns subchannels in a segment. The exact partitioning into subchannels in each segment is according to the following equation.~~

$$Tile(s,m) = \begin{cases} N_s m + \lfloor s + P_{1,c_1}(m') + P_{2,c_2}(m') \rfloor & 0 < c_1, c_2 < N_s \\ N_s m + \lfloor s + P_{1,c_1}(m') \rfloor & c_1 \neq 0, c_2 = 0 \\ N_s m + \lfloor s + P_{2,c_2}(m') \rfloor & c_1 = 0, c_2 \neq 0 \\ N_s m + s, & c_1 = 0, c_2 = 0 \end{cases} \quad (2)$$

~~where~~

~~Tile(s, m) = tile index of m-th tile in subchannel s.~~

~~m = tile-in-subchannel index from the set [0 ~ 5]~~

$m' = m \bmod 31$

~~s = index number of a subchannel within a group of band from the set [0 ~ Ns -1]~~

P1,c1(j)= j-th element of the sequence obtained by rotating basic permutation sequence P1 cyclically to the left c1 times. P1 is shown in Table 309a.
P2,c2(j)= j-th element of the sequence obtained by rotating basic permutation sequence P2 cyclically to the left c2 times. P2 is shown in Table 309a.
c1 = IDcell mod 32, c2 =IDcell/32.

In Equation (2), the operation in [ ] is over GF(25). In GF(25), addition is binary XOR operation. For example, 29 + 12 in GF(25) is [(11101)2 **XOR** (01100)2] = (10001)2 = 17, where (x)2 represents binary expansion of x.

Table 4 Parameters for subcarrier allocation in optional PUSC type II

FFT size	L	M	Ns
1024	8	96	16
2048	16	192	32

After allocating the tiles for each subchannel the enumeration of the data subcarriers per subchannel is exactly the same as one described in section 8.4.6.2.5 Additional optional symbol structure for PUSC.

Type III-A

Add the following section :

8.4.6.1.2.6 Additional optional symbol structure for PUSC type III-A

For 2048 FFT, Nused subcarriers are divided into 48 bands of contiguous subcarriers which are indexed from 0 to 47. Even numbered bands are used for FUSC and odd numbered bands are used for PUSC. 24 bands for PUSC are divided into 3 segments, which are used for different sectors respectively. The subcarrier allocation for FUSC + PUSC operation is described in Table 5. Similar subcarrier allocation for 1024 FFT is shown in Table 6.

Table 5 2048 FFT downlink subcarrier allocation for PUSC type III-A

parameters	value	comments
Number of DC Subcarriers	1	
Number of Guard Subcarriers, Left	160	
Number of Guard Subcarriers, Right	159	
Number of Used Subcarriers(Nused) (including all possible allocated pilots and the DC carrier)	1729	
Number of Pilot Subcarriers	192	
Pilot subcarrier index	9k+3m+1, for k=0,…, 191 and m=[symbol index]mod3	Symbol of index 0 is the first symbol of a frame
Number of Data Subcarriers	1536	Data subcarriers are reordered and indexed as 0 ~ 1535
Number of Data Subcarriers for FUSC	768	Data subcarriers in odd numbered bands
Number of Data Subcarriers for PUSC	768	PUSC zone #1 : band 6k PUSC zone #2 : band 6k+2 PUSC zone #3 : band 6k+4

		k = 0,1,…,7

Table 6 1024 FFT downlink subcarrier allocation for PUSC type III-A

parameters	value	comments
Number of DC Subcarriers	1	
Number of Guard Subcarriers, Left	80	
Number of Guard Subcarriers, Right	79	
Number of Used Subcarriers(Nused) (including all possible allocated pilots and the DC carrier)	865	
Number of Pilot Subcarriers	96	
Pilot subcarrier index	9k+3m+1, for k=0,…, 95 and m=[symbol index]mod3	Symbol of index 0 is the first symbol of a frame
Number of Data Subcarriers	768	Data subcarriers are reordered and indexed as 0 ~ 767
Number of Data Subcarriers for FUSC	384	Data subcarriers in odd numbered bands
Number of Data Subcarriers for PUSC	384	PUSC zone #1 : band 6k PUSC zone #2 : band 6k+2 PUSC zone #3 : band 6k+4 k = 0,1,…,3

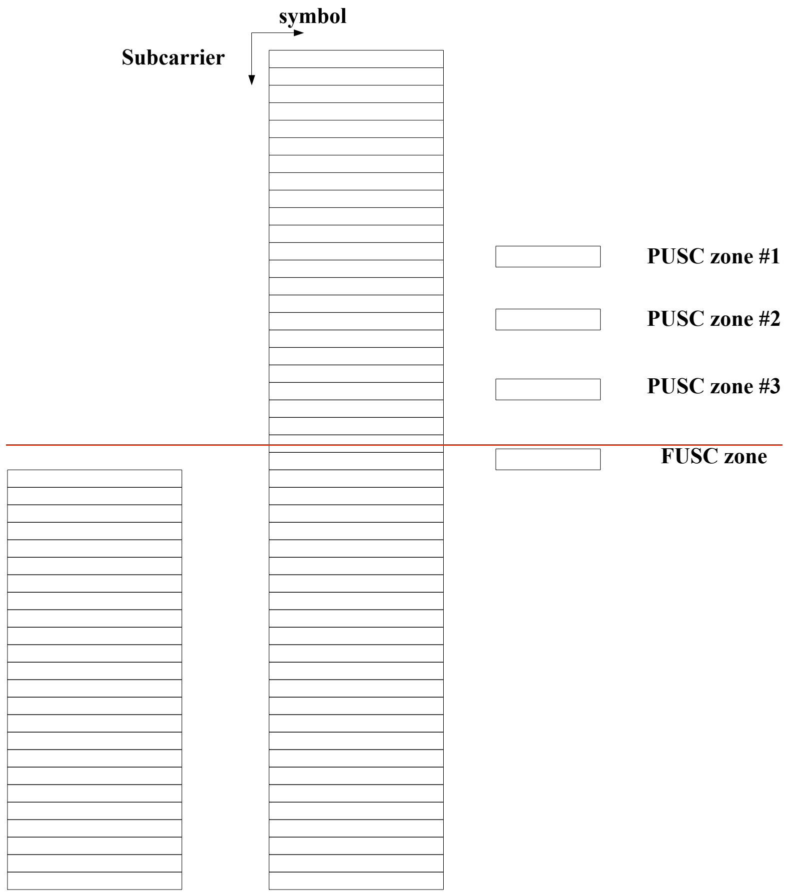


Figure 5 subcarrier allocation for PUSC type III-A

8.4.6.1.2.6.1 Downlink subchannels subcarrier allocation for FUSC zone in PUSC type III-A

Subchannels subcarrier allocation for FUSC zone in PUSC type III-A is according to permutation formula in section 8.4.6.1.2.3.1. For 2048 FFT, the parameters for 1024 FFT of Table 309a shall be used. For 1024 FFT, the parameters for 512 FFT of Table 309a shall be used.

8.4.6.1.2.6.2 Downlink subchannels subcarrier allocation for PUSC zone in PUSC type III-A

To allocate the diversity subchannels in each PUSC, the data tones in 3 symbols in a segment are divided into 48 groups of 16 contiguous subcarriers. Each subchannel consists of one subcarrier from each of these groups.

To allocate the diversity subchannels in each PUSC zone, data tones in 3 consecutive symbols in a segment are partitioned into 48 groups of contiguous data subcarriers. Each subchannel consists of one subcarrier from each of these groups. The enumeration of the subcarriers in a segment within three symbols starts from the lowest numbered data subcarrier of the first symbol in a segment and goes to the next carriers. If it reaches the last carrier in the symbol in the segment, it goes to the lowest data carrier of the next symbol and so on. The exact partitioning into subchannels is according to the permutation formula in section 8.4.6.1.2.3.1. If FFT size is 1024, then Ns is 8. If FFT size is 2048, then Ns is 16. The basic permutation sequences P1 and P2 are shown in Table 309a.

8.4.6.2.9 Subcarrier allocation in the uplink for optional PUSC type III-A

In PUSC type III-A, even numbered bands are used for FUSC zone and odder numbered bands are used for PUSC zones. A burst in the uplink is composed of 3 time symbols and 1 subchannel, within each burst, there are 48 data subcarriers and 6 fixed-location pilot subcarrier. The subchannel is constructed from 6 uplink tiles, each tile has 3 subcarriers and it's configuration is illustrated in Figure 237.

Tiles in three symbols are divided into 24/48 groups of contiguous tiles with respect to the FFT size. Each group may correspond to one band in AMC permutation. Even numbered group is used for FUSC and odd numbered groups are used

~~for PUSC. PUSC groups are divided into 3 subgroups each of which is used for each PUSC zone. The subcarrier allocation for PUSC type III-A operation is described in Table 7.~~

~~Table 7 uplink subcarrier allocation for PUSC type III-A in 2048 FFT~~

~~parameters~~	~~value~~	~~comments~~
~~Number of DC Subcarriers~~	~~1~~	
~~Number of Guard Subcarriers, Left~~	~~160~~	
~~Number of Guard Subcarriers, Right~~	~~159~~	
~~Number of Used Subcarriers(Nused) (including all possible allocated pilots and the DC carrier)~~	~~1729~~	
~~Number of tiles~~	~~576~~	~~Tiles are indexed as 0 ~ 575~~
~~Number of tiles for FUSC~~	~~288~~	~~Tiles in even numbered bands~~
~~Number of tiles for PUSC zones~~	~~288~~	~~Tiles in odd numbered bands~~

~~Table 8 uplink subcarrier allocation for PUSC type III-A in 1024 FFT~~

~~parameters~~	~~value~~	~~comments~~
~~Number of DC Subcarriers~~	~~1~~	
~~Number of Guard Subcarriers, Left~~	~~80~~	
~~Number of Guard Subcarriers, Right~~	~~79~~	
~~Number of Used Subcarriers(Nused) (including all possible allocated pilots and the DC carrier)~~	~~865~~	
~~Number of tiles~~	~~288~~	~~Tiles are indexed as 0 ~ 287~~
~~Number of tiles for FUSC~~	~~144~~	~~Tiles in even numbered bands~~
~~Number of tiles for PUSC zones~~	~~144~~	~~Tiles in odd numbered bands~~

~~8.4.6.2.9.1 subchannels tile allocation for FUSC zone~~

~~To allocate the diversity subchannels in FUSC, the Ntf tiles for FUSC are reindexed as 0 ~ Ntf -1 and then divided into 18 groups of Ns logically contiguous tiles. Each subchannel consists of 6 tiles, each of which is chosen from 6 different groups at equal distance (3 groups away from each). Thus a subchannel consists of 48 data subcarriers since a tile consists of 8 data tones and 1 pilot tone. The exact partitioning into subchannels is according to Equation (3).~~

$$Tile(s,m) = \begin{cases} 3N_s m + N_s S + \lfloor s' + P_{1,c_1}(m') + P_{2,c_2}(m') \rfloor & 0 < c_1, c_2 < N_s \\ 3N_s m + N_s S + \lfloor s' + P_{1,c_1}(m') \rfloor & c_1 \neq 0, c_2 = 0 \\ 3N_s m + N_s S + \lfloor s' + P_{2,c_2}(m') \rfloor & c_1 = 0, c_2 \neq 0 \\ 3N_s m + N_s S + s', & c_1 = 0, c_2 = 0 \end{cases} \quad (3)$$

~~where~~

~~Tile(s, m) = tile index of m-th tile in subchannel s.~~
~~S = ⌊s/Ns⌋, s' = s mod Ns~~
~~m = tile-in-subchannel index from the set [0 ~ 5]~~
$m' = m \bmod N_s - 1$
~~s = index number of a subchannel from the set [0 ~ 48]~~
~~P1,c1(j)= j-th element of the sequence obtained by rotating basic permutation sequence P1 cyclically to the left c1 times. P1 is shown in Table 309a based upon the value of Ns.~~
~~P2,c2(j)= j-th element of the sequence obtained by rotating basic permutation sequence P2 cyclically to the left c2 times. P2 is shown in Table 309a based upon the value of Ns.~~
~~c1 = IDcell mod Ns, c2 = ⌊IDcell/ Ns ⌋~~

~~In Equation (3), the operation in [ ] is over GF(Ns). In GF(2n), addition is binary XOR operation. For example, 13 + 4 in GF(16) is [(1101)2 **XOR** (0100)2]= (1001)2 = 9, where (x)2 represents binary expansion of x.~~

~~Table 9 Parameters for subchannel subcarrier allocation for FUSC zone in PUSC type III-A~~

~~FFT size~~	~~Ntf~~	~~Ns~~
~~1024~~	~~144~~	~~8~~
~~2048~~	~~288~~	~~16~~

~~8.4.6.2.9.2 subchannels subcarrier allocation for PUSC zone~~

~~To allocate the diversity subchannels in each PUSC, the Ntp tiles for PUSC are reindexed as 0 ~ Ntp -1 and then divided into 6 groups of Ns logically contiguous tiles. Each subchannel consists of 6 tiles, each of which is chosen from each group. Thus a subchannel consists of 48 data subcarriers. The exact partitioning into subchannels is according to Equation (2) in section 8.4.6.2.8. The parameter Ns is given in Table 10.~~

~~Table 10 Parameters for subchannel subcarrier allocation for PUSC zone in PUSC type III-A~~

~~FFT size~~	~~Ntp~~	~~Ns~~
~~1024~~	~~48~~	~~8~~
~~2048~~	~~96~~	~~16~~

~~Type III-B~~

~~Add the following section :~~

~~8.4.6.1.2.7 Additional optional symbol structure for PUSC type III-B in the downlink~~

~~For 2048 FFT, Nused subcarriers are divided into 48 bands of contiguous subcarriers which are indexed from 0 to 47. Even numbered bands are used for FUSC zone and odd numbered bands are used for PUSC zone. The partition of subcarriers in three symbols is shown in Figure 6. The subcarrier allocation for PUSC type III-B operation is described in Table 11. Similar subcarrier allocation for 1024 FFT is shown in Table 12.~~

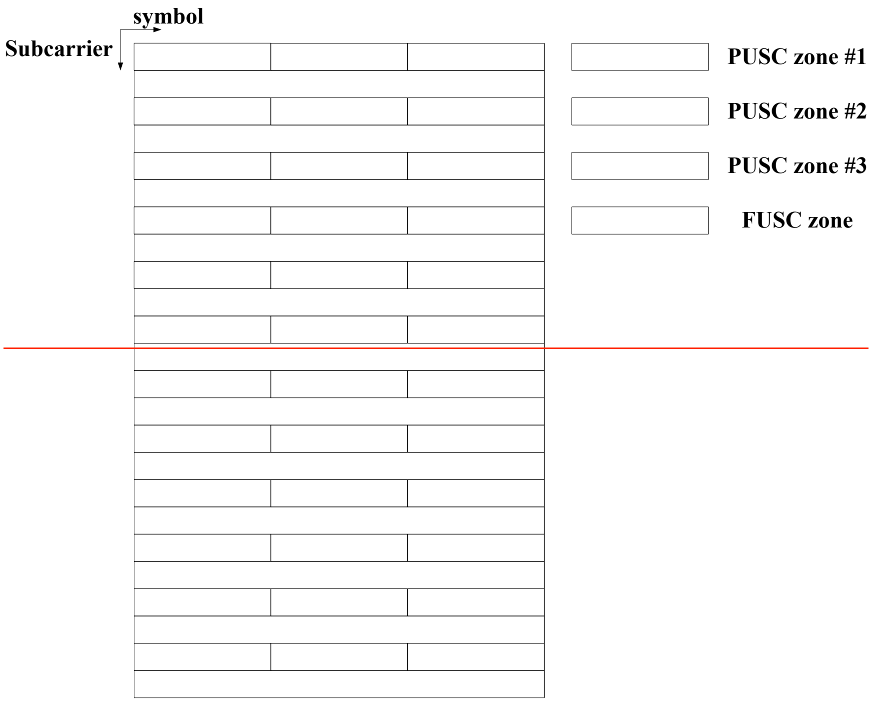
~~Table 11 2048 FFT downlink subcarrier allocation for PUSC type III-B~~

~~parameters~~	~~value~~	~~comments~~
~~Number of DC Subcarriers~~	~~1~~	
~~Number of Guard Subcarriers, Left~~	~~160~~	
~~Number of Guard Subcarriers, Right~~	~~159~~	
~~Number of Used Subcarriers(Nused) (including all possible allocated pilots and the DC carrier)~~	~~1729~~	
~~Number of Pilot Subcarriers~~	~~192~~	
~~Pilot subcarrier index~~	~~9k+3m+1, for k=0,…, 191 and m=[symbol index]mod3~~	~~Symbol of index 0 is the first symbol of a frame~~
~~Number of Data Subcarriers~~	~~1536~~	~~Data subcarriers are reordered and indexed~~

		as 0 ~ 1535
Number of Data Subcarriers for FUSC	768	Data subcarriers in odd numbered bands
Number of Data Subcarriers for PUSC	768	Data subcarriers in eve numbered bands PUSC zone #1 : bands in the first symbol PUSC zone #2 : bands in the second symbol PUSC zone #3 : bands in the third symbol

Table 12 1024 FFT downlink subcarrier allocation for PUSC type III-B

parameters	value	comments
Number of DC Subcarriers	1	
Number of Guard Subcarriers, Left	80	
Number of Guard Subcarriers, Right	79	
Number of Used Subcarriers(Nused) (including all possible allocated pilots and the DC carrier)	865	
Number of Pilot Subcarriers	96	
Pilot subcarrier index	9k+3m+1, for k=0,…, 95 and m=[symbol index]mod3	Symbol of index 0 is the first symbol of a frame
Number of Data Subcarriers	768	Data subcarriers are reordered and indexed as 0 ~ 767
Number of Data Subcarriers for FUSC	384	Data subcarriers in odd numbered bands
Number of Data Subcarriers for PUSC	384	Data subcarriers in even numbered bands PUSC zone #1 : bands in the first symbol PUSC zone #2 : bands in the second symbol PUSC zone #3 : bands in the third symbol



~~**Figure 6 Subcarrier allocation for PUSC type III-B in 1024 FFT**~~

~~**8.4.6.1.2.7.1 Downlink subchannels subcarrier allocation for FUSC zone in PUSC type III-B**~~

~~Subchannels subcarrier allocation for FUSC zone in PUSC type III-B is according to the permutation formula in section 8.4.6.1.2.3.1. For 2048 FFT, the parameters for 1024 FFT of Table 309a shall be used. For 1024 FFT, the parameters for 512 FFT of Table 309a shall be used.~~

~~**8.4.6.1.2.7.2 Downlink subchannels subcarrier allocation for PUSC zone in PUSC type III-B**~~

~~Subchannels subcarrier allocation for each PUSC zone in PUSC type III-B is the same as FUSC zone case in section 8.4.6.1.2.7.1 Downlink subchannels subcarrier allocation for FUSC zone in PUSC type III-B.~~

~~**8.4.6.2.10 Subcarrier allocation in the uplink for optional PUSC type III-B**~~

~~In PUSC type III-B, even numbered bands are used for FUSC zone and odder numbered bands are used for PUSC zones. A burst in the uplink is composed of 3 time symbols and 1 subchannel, within each burst, there are 48 data subcarriers and 6 fixed-location pilot subcarrier. The subchannel is constructed from 6 uplink tiles, each tile has 3 subcarriers and it's configuration is illustrated in Figure 237.~~

~~tiles in three symbols are divided into 24/48 groups of contiguous tiles with respect to the FFT size. Each group may correspond to one band in AMC permutation. Even numbered group is used for FUSC and odd numbered groups are used for PUSC. PUSC groups are divided into 3 subgroups each of which is used for each PUSC zone. The subcarrier allocation for PUSC type III-B operation is described in Table 13 and Table 14.~~

~~**Table 13 uplink subcarrier allocation for PUSC type III-B in 2048 FFT**~~

~~parameters~~	~~value~~	~~comments~~
~~Number of DC Subcarriers~~	~~1~~	
~~Number of Guard Subcarriers, Left~~	~~160~~	
~~Number of Guard Subcarriers, Right~~	~~159~~	
~~Number of Used Subcarriers(Nused) (including all possible allocated pilots and the DC carrier)~~	~~1729~~	

Number of tiles	576	Tiles are indexed as 0 ~ 575
Number of tiles for FUSC	288	Tiles in even numbered bands
Number of tiles for PUSC	288	Tiles in odd numbered bands

Table 14 uplink subcarrier allocation for PUSC type III-B in 1024 FFT

parameters	value	comments
Number of DC Subcarriers	1	
Number of Guard Subcarriers, Left	80	
Number of Guard Subcarriers, Right	79	
Number of Used Subcarriers(Nused) (including all possible allocated pilots and the DC carrier)	865	
Number of tiles	288	Tiles are indexed as 0 ~ 287
Number of tiles for FUSC	144	Tiles in even numbered bands
Number of tiles for PUSC	144	Tiles in odd numbered bands

8.4.6.2.10.1 subchannels tile allocation for FUSC zone

To allocate the diversity subchannels in FUSC, the Ntf tiles for FUSC are reindexed as 0 ~ Ntf -1 and then divided into 18 groups of Ns logically contiguous tiles. Each subchannel consists of 6 tiles, each of which is chosen from 6 different groups at equal distance (3 groups away from each). Thus a subchannel consists of 48 data subcarriers since a tile consists of 8 data tones and 1 pilot tone. The exact partitioning into subchannels is according to Equation (4).

$$Tile(s,m) = \begin{cases} 3N_s m + N_s S + \left[s' + P_{1,c_1}(m') + P_{2,c_2}(m') \right] & 0 < c_1, c_2 < N_s \\ 3N_s m + N_s S + \left[s' + P_{1,c_1}(m') \right] & c_1 \neq 0, c_2 = 0 \\ 3N_s m + N_s S + \left[s' + P_{2,c_2}(m') \right] & c_1 = 0, c_2 \neq 0 \\ 3N_s m + N_s S + s', & c_1 = 0, c_2 = 0 \end{cases} \quad (4)$$

where

Tile(s, m) = tile index of m-th tile in subchannel s.

S = ⌊s/Ns⌋, s' = s mod Ns

m = tile-in-subchannel index from the set [0 ~ 5]

$m' = m \bmod N_s - 1$

s = index number of a subchannel from the set [0 ~ 48]

P1,c1(j)= j-th element of the sequence obtained by rotating basic permutation sequence P1 cyclically to the left c1 times. P1 is shown in Table 309a based upon the value of Ns.

P2,c2(j)= j-th element of the sequence obtained by rotating basic permutation sequence P2 cyclically to the left c2 times. P2 is shown in Table 309a based upon the value of Ns.

c1 = IDcell mod Ns, c2 = ⌊IDcell/ Ns ⌋

In Equation (4), the operation in [ ] is over GF(Ns). In GF(2n), addition is binary XOR operation. For example, 13 + 4 in GF(16) is [(1101)2 **XOR** (0100)2]= (1001)2 = 9, where (x)2 represents binary expansion of x.

Table 15 Parameters for subchannel subcarrier allocation for FUSC zone in PUSC type III-B

FFT size	Ntf	Ns
1024	144	8
2048	288	16

~~**8.4.6.2.10.1 subchannels tile allocation for PUSC zone**~~

~~Subchannels tile allocation for each PUSC zone in PUSC type III-B is the same as FUSC zone case in section 8.4.6.2.10.1 subchannels tile allocation for FUSC zone.~~