Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Proposed Text of UL Subchannelization Section for the IEEE 802.16m Amendment**
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Re	"IEEE 802.16m amendment text" IEEE 802.16m-08/042, "Call for Contributions on Project 802.16m Draft Amendment Content". Target topic: "Uplink Physical Structure (data plane only)"
Abstract	The contribution proposes the text of uplink physical structure section (11.6) to be included in the 802.16m amendment.
Purpose	To be discussed and adopted by TGm for the 802.16m amendment.
Notice	
Release	
Patent Policy	

Proposed Text of UL Subchannelization for the IEEE 802.16m Amendment

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1. Introduction

The contribution proposes the text of uplink subchannelization to be included in the 802.16m amendment. The proposed text is developed so that it can be readily combined with IEEE P802.16 Rev2/D7 [1], it is compliant to the 802.16m SRD [2] and the 802.16m SDD [3] , and it follows the style and format guidelines in [4].

2. Modifications to the SDD text

The text proposed in this contribution is based on the subclauses 11.6 in the IEEE 802.16m SDD [3]. Additionally, we have added and modified as follows:

- The overall text and figures in this contribution are compliant with the IEEE 802.16m SDD [3] except the depth of details for subchannelization.

3. References

[1] IEEE P802.16 Rev2 / D7, “Draft IEEE Standard for Local and Metropolitan Area Networks: Air Interface for Broadband Wireless Access,” Oct. 2008.

[2] IEEE 802.16m-07/002r6, “802.16m System Requirements”

[3] IEEE 802.16m-08/003r5, “The Draft IEEE 802.16m System Description Document”

[4] IEEE C802.16m-08/043, “Style guide for writing the IEEE 802.16m amendment”

4. Text proposal for inclusion in the 802.16m amendment

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Insert a new section 15:

15. Advanced Air Interface

15.3. Physical layer

15.3.6.3. Subchannelization and Resource Mapping

15.3.6.3.1. Basic Symbol Structure

15.3.6.3.2. Permutation Sequence Generation

All permutations used for uplink subchannelization shall be generated using a permutation sequence generation algorithm which is explained below. The algorithms takes a 20-bit seed (S_{n-20}, S_{n-19}, … , S_{n-1}) and a permutation size M as inputs and outputs a permutation of a set {0, 1, … , M-1}.

The permutation sequence generation algorithm shall generate a permutation sequence of size M by the following process:

1) Initialization

   A. Initialize the variables of the first order polynomial equation with the 20-bit seed, SEED

      i. Set d_1 = floor(SEED/2^{10}) + 1

      ii. Set d_2 = (SEED mod 2^{10})

   B. Initialize the maximum iteration number, N

   C. Initialize an array A with size M with the numbers 0, 1, … , M-1 (i.e. A[0]=0, A[1]=1, … , A[M-1]=M-1)

   D. Initialize the counter i to M-1

   E. Initialize x to -1

2) Repeat the following steps if $i > 0$,

   A. Initialize the counter j to 0

   B. Repeat the following steps if $y \geq i$ and $j < N$

      i. Increment x by 1

      ii. Calculate the output variable of the first order polynomial, $y = \{(d_1 \times x + d_2) \bmod 1048583\} \bmod M$

iii. Increment j by 1

C. If $y > i$, set $y = y \bmod i$

D. Swap the i-th and the y-th elements in the array (i.e. perform the steps Temp=A[i], A[i]=A[y], A[y]=Temp)

E. Decrement i by 1

3) The permuted sequence is represented by $Perm(M, \text{SEED}) = \{A[0], A[1], \ldots, A[M-1]\}$.

15.3.6.3.3. Uplink Subcarrier to Resource Unit Mapping

The uplink subcarrier to resource unit mapping process is defined as follows and illustrated in Figure 1:

1. First-level or outer permutation is applied to the PRUs in the units of N_1 and N_2 PRUs, where N_1=4 and N_2 =1 or 2 depending on system bandwidth. Direct mapping of outer permutation can be supported only for CRU.

2. Distributing the reordered PRUs into frequency partitions.

3. The frequency partition is divided into CRU and/or DRU for each resource group. Sector specific permutation can be supported and direct mapping of the resources can be supported for localized resources. The sizes of the distributed/localized resources are flexibly configured per sector. Adjacent sectors do not need to have same configuration of localized and distributed resources

4. The localized and distributed groups are further mapped into LRUs by direct mapping of CRU and by inner permutation on DRUs.

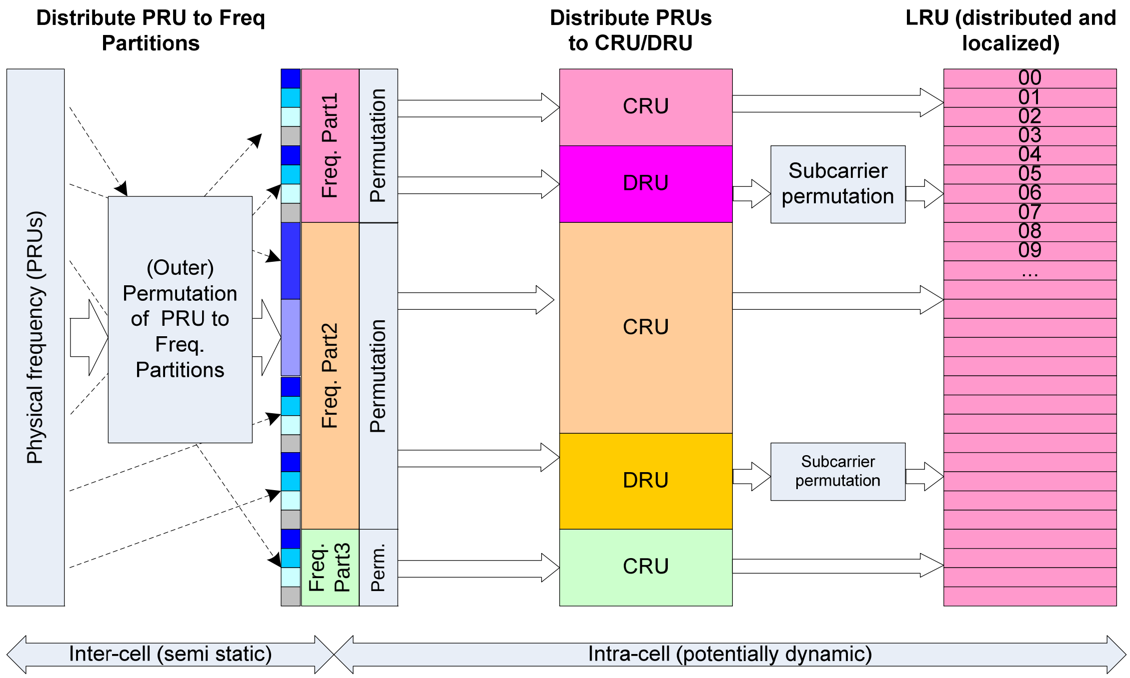

Figure 1 – Illustration of the uplink subcarrier to resource block mapping.

In Figure 2, an example of uplink subcarrier to resource block mapping is described in detail. In the figure, the size of bandwidth is 10MHz and the size of N_2 is equal to 1.

[TBD]

Figure 2 – An example of uplink subcarrier to resource block mapping (BW=10MHz, N_2=1)

15.3.6.3.3.1. Outer Permutation

Outer permutation has two stage procedures:

1) The first stage is to reserve frequency resources as the unit of N_1 PRUs and to enumerate the remained PRUs which are not reserved, as shown in Figure 2.

- Band selection function, f_{BS} is given as follow:

    i. The location of PRUs for the reserved bands is determined according to the number of reserved bands (N_{res_band}) indicated by SBCH [3].

    ii. [TBD]

- Except for the selected bands, the enumeration is applied with the remained PRUs. Enumeration function, $f_{out\text{-}1}(i)$ is given as follows:

i. Initialization

1. N_{PRU} is the total number of PRUs according to the system bandwidth.

2. Initialize *i* to 0

3. Initialize *j* to 0

ii. Repeat the following step if $j < N_{PRU}$,

1. If the *j*-th PRU is reserved for band selection,

A. Set the function of enumeration, $f_{out-1}(i) = j$

B. Increase *i* by 1

2. Increase *j* by 1

2) The second stage is for the enumerated PRUs which are passed through the function of f_{out-1}.

- Using first permutation in the unit of N_2 PRUs as shown in Figure 2, the enumerated PRUs are permuted as described below (TBD)

i. [TBD]

15.3.6.3.3.2. Second Permutation

Second permutation is performed within each partition for all partitions except the partition for band selection as the unit of N_1 PRUs.

- Reordered PRUs within a partition is once again permuted by *Perm*(*M*, SEED) where *M* is the number of PRUs within a specific partition. The algorithm of *Perm*(*M*, SEED) is described in 15.3.5.3.2.

- Perm(M, SEED) function generate the randomized sequence with length of M. For example, in case of A=Perm(M, SEED), A stands for sequence with length of M. A[x] means the x-th element of sequence A.

i. SEED = [(IDcell + 1024*m)*1357351] mod 2^{20}, where IDcell is the cell identification of each sector and *m* means the subframe index.

For the second permutation in frequency reuse 1 region, the reordered PRUs as the input of second permutation include the PRUs which are selected as the reserved bands in the outer permutation procedure, as shown in Figure 2. If the number of bands for band selection operation as the unit of N_1 PRUs (N_{BS_N1}) is smaller than the number of reserved bands (N_{res_band}), the PRUs within the remained bands can be utilized for distributed resource. That is, the remained PRUs which are not used for localized LRU in the unit of N_1 PRUs are also permuted by second permutation in frequency reuse 1 region. If N_{BS_N1} is equal to N_{res_band}, there are no remained PRUs for second permutation in frequency reuse 1 region. Therefore, each sector can have the different configuration of band selection and frequency diversity resource.

15.3.6.3.3.3. Tile Permutation

The tile permutation defined for the uplink distributed resource allocations within a frequency partition spreads the tiles of the DRU across the whole distributed resource allocations. The granularity of the tile permutation is equal to the tile size for forming a DRU according to section 11.6.1.1.

- All DRUs in every frequency partitions are split into tiles.
- Enumerate all tiles within a frequency partition for all partitions.
- All tiles within a partition is permuted by Perm(M, SEED) where M is the number of tiles within the partition. The algorithm of Perm(M, SEED) is described in 15.3.6.3.2.
- Perm(M, SEED) function generates the randomized sequence with length of M. For example, in case of A=Perm(M, SEED), A stands for sequence with length of M. A[x] means the x-th element of sequence A.

    i. Here, SEED = [(IDcell + 1024*m)*1357351] mod 220, where IDcell is the cell identification of each sector and m means the subframe index.

The indexing of distributed LRU is explained in 15.3.6.3.4.

15.3.6.3.4. Subchannelization for Uplink Distributed Resource

[TBD]

15.3.6.3.5. Subchannelization for Uplink Localized Resource

There is no permutation defined for the uplink localized resource allocation. The PRUs are directly mapped to localized LRUs within each frequency partition.

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