Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Modified DL subcarrier to resource unit mapping**
Date Submitted	**2008-07-07**

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Re:	IEEE 802.16m-08/024, “Call for Comments and Contributions on Project 802.16m System Description Document (SDD)”. Target topic: “DL Physical Structure
Abstract	This contribution provides the modified text for Downlink subcarrier to resource unit mapping (sub-clause 11.5.2.2) in the IEEE 802.16m SDD
Purpose	To be discussed and adopted by TGm for the 802.16m SDD.
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Modified DL subcarrier to resource unit mapping

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1. Introduction

In the current IEEE 802.16m SDD, the unit size of outer permutation in DL subcarrier to resource unit mapping is N PRUs, where N is TBD. According to the unit size of N PRUs, however, there is a performance trade-off in the current DL subcarrier to resource unit mapping. In this contribution, the shortcoming of current resource unit mapping block is present by investigating the performance trade-off and new DL subcarrier to resource unit mapping is proposed.

2. Motivation

In the current DL subcarrier to resource unit mapping, there is a performance trade-off between frequency diversity gain for DRU in frequency reuse-N region and the system overhead according to the size of N, as described in Table 1.

When the size of N is small (e.g. 1 or 2 PRUs), it is available to achieve frequency diversity gain for DRU in each frequency reuse region. To achieve the band selection gain, however, many resource indications shall be necessary for resource units for LLRU spread out different subbands, which causes the increase of assignment indication overhead. Moreover, remote fractions of resource unit for LLRU spread out different subbands make less flexible on scheduling/assignment indication and CQI transmission. For example, it is not available to assign the consecutive M PRUs for LLRU with only one assignment indication, where M is larger than N. If a specific subband is allocated for LLRU, a multiple of assignment indications shall be necessary to assign the consecutive PRUs for LLRU, which results in the increase of assignment indication overhead as well. In another case, the number of available resource units for LLRU is small because the allocable resource units for LLRU are limit to the size of N PRUs. Finally, in case that CL-MIMO is used in PRUs assigned for LLRU, CQI/PMI feedback overhead shall be increased when the resource unit size of LLRU is small. It is because the number of resource units for LLRU spread out whole frequency band is relatively large, and these kinds of feedback information on each resource unit are indispensable for CL-MIMO operation.

On the other hand, in case that the size of N is large, the features are opposite to the case of small N PRUs. That is, overall system overhead for operation of LLRU and CL-MIMO is relatively small compared with the case of small N PRUs. In addition, more flexibility on scheduling/assignment indication can be provided because of large N PRUs. However, it is difficult to achieve frequency diversity gain for DRU in each frequency reuse-N region because the resource units for DRU are not sufficiently spread out whole frequency band.

From Table 1, it can be seen that there is an obvious performance trade-off between frequency diversity gain for DRU in frequency reuse-N region and the system overhead, according to the size of N PRUs. But, it is hard to

find out the solution to achieve both gains simultaneously in the current subchannelization structure. Therefore, the modified DL subcarrier to resource unit mapping shall be necessary to meet the requirements which are to achieve the frequency diversity gain for DRU in frequency reuse-N region and to use LLRU in at least frequency reuse-1 region without additional indication/feedback overhead.

Table 1 – Performance trade-off in current subchannelization structure according to the value of N

	Pros	Cons
Small value of N	• Frequency diversity gain for DRU in each frequency reuse-N region	• Increase resource assignment overhead for band selection gain • Less flexibility on scheduling / assignment indication and CQI transmission due to remote fractions of resource unit for LLRU spread out different subbands • Increase CQI/PMI feedback overhead for CL-MIMO
Large value of N	• Less resource assignment overhead for band selection gain • More flexibility on scheduling / assignment indication and CQI transmission • Less CQI/PMI feedback overhead for CL-MIMO	• No guarantee frequency diversity gain for DRU in each frequency reuse-N region

3. Proposed DL subcarrier to resource unit mapping

In order to meet the requirements mentioned above, a modified DL subcarrier to resource unit mapping is proposed as described in Figure 1.
The detail procedure to map DL subcarrier to resource unit is as follows:

- Firstly assign the resource units for frequency reuse-N region as the unit of 1 PRU. The location for frequency reuse N region shall be predefined according to the ratio of FFR ratio index which is given by Broadcast Channel (BCH) as defined in 11.6.2.2 [TBD].

- Reserve the resource units for LLRUs in the frequency reuse-1 region as the unit of subband defined as the consecutive 4 PRUs, except for the assigned resource units for frequency reuse-N region in the previous step. The localized resource units shall be located at the specific region, which is predefined according to the number of LLRUs in frequency reuse-1 region which is given by BCH [TBD].

- Within the resource units in each frequency reuse-N region, apply the renumbering and inter-cell permutation as the unit of 1 PRU. The inter-cell permutation shall be common between the neighbor cells/sectors using fractional frequency reuse. After applying the permutation based on PRU, the procedure to make the groups for each cell/sector shall be performed. The resource within each group shall be divided into LLRU and DRU using the PRU as the unit. At each group, different resource unit mapping can be applied

- Within the remaining resource units (e.g. for distributed resource in frequency reuse-1 region) after assigning resource units for frequency reuse-N region and LLRUs for frequency reuse-1 region, apply the renumbering and intra-cell permutation as the unit of 1 PRU. Each cell/sector has the different intra-cell permutation sequences with the cell/sector specific information. After applying the permutation based on 1 PRU, PRU-based DRUs in frequency reuse-1 region shall be selected among the assigned PRUs. With the remaining PRUs, the permutation based on tone shall be performed to make tone-based DRUs in frequency reuse-1 region.

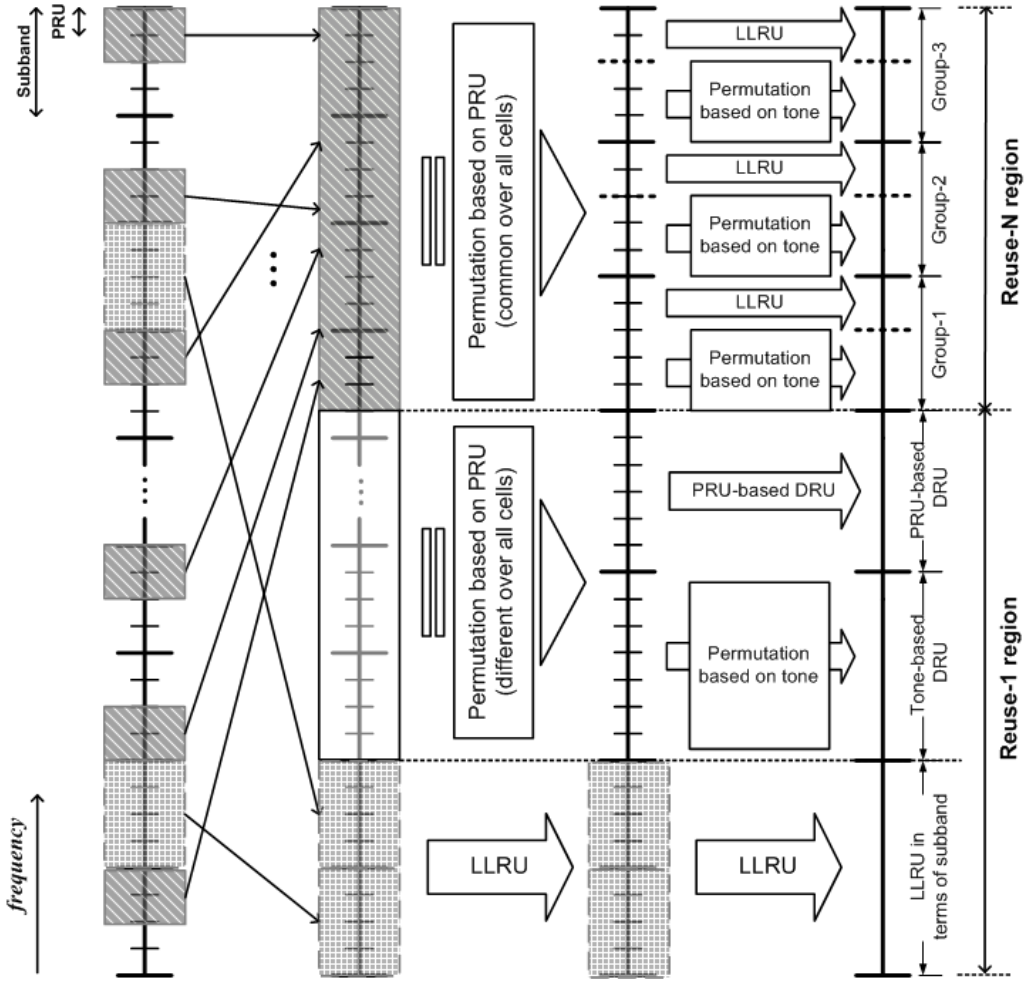


Figure 1 – Proposed DL subcarrier to resource unit mapping structure

4. Conclusion

In this contribution, the proposed DL subcarrier to resource unit mapping is discussed. The proposed structure is able to resolve the weak points in the current DL subcarrier to resource unit mapping and meet the requirements mentioned above. Therefore, we suggest adopting the proposed subchannelization procedure for 16m DL subcarrier to resource unit mapping.

5. Text Proposal for Modification in 802.16m SDD

Change the text in Downlink subcarrier to resource unit mapping Sub-clause as follows:

----------Start of the text----------

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

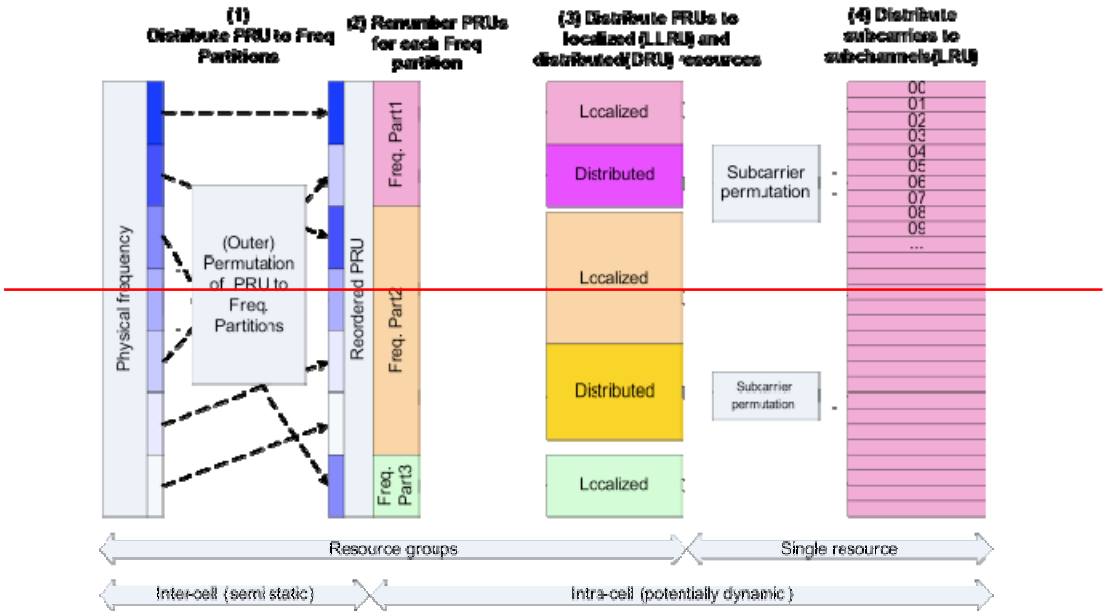
~~1. First level or outer permutation is applied to the PRUs in the units of N PRUs, where N is TBD;~~

~~2. Distributing (TBD) the reordered PRUs into frequency partitions.~~

~~3. The frequency partition is divided into localized (LLRU) and/or distributed (DRU) resources using the PRU as unit for each resource. The sizes of the groups are flexibly configured per sector (TBD). Adjacent sectors do not need to have same configuration of localized and diversity groups;~~

~~4. The localized and distributed groups are further mapped into LRUs (by direct mapping of LLRU and by "Subcarrier permutation" on DRUs) as shown in the following figure.~~

1. Firstly assign the resource units for frequency reuse-N region as the unit of 1 PRU. The location for frequency reuse-N region shall be predefined according to the ratio of FFR ratio index
2. Reserve the resource units for LLRUs in the frequency reuse-1 region as the unit of subband defined as the consecutive 4 PRUs, except for the assigned resource units in frequency reuse-N region in the previous step. The localized resource units shall be located at the specific region, which is predefined according to the number of LLRUs in frequency reuse-1 region.
3. Within the resource units in each frequency reuse-N region, apply the renumbering and inter-cell permutation as the unit of 1 PRU. The inter-cell permutation shall be common between the neighbor cells using fractional frequency reuse. After applying permutation based on PRU, the procedure to make the groups for each sector shall be performed. The resource within each group shall be divided into LLRU and DRU using the PRU as the unit. At each group, different resource unit mapping can be applied
4. Within the remaining resource units (e.g. for DRU in frequency reuse-1 region) after assigning resource units for frequency reuse-N region and LLRUs in frequency reuse-1 region, apply the renumbering and intra-cell permutation as the unit of 1 PRU. Each cell has the different intra-cell permutation sequences with the cell specific information. After applying permutation based on 1 PRU, PRU-based DRUs in frequency reuse-1 region shall be selected among the assigned PRUs. With the remaining PRUs, the permutation based on tone shall be performed to make tone-based DRUs in frequency reuse-1 region.



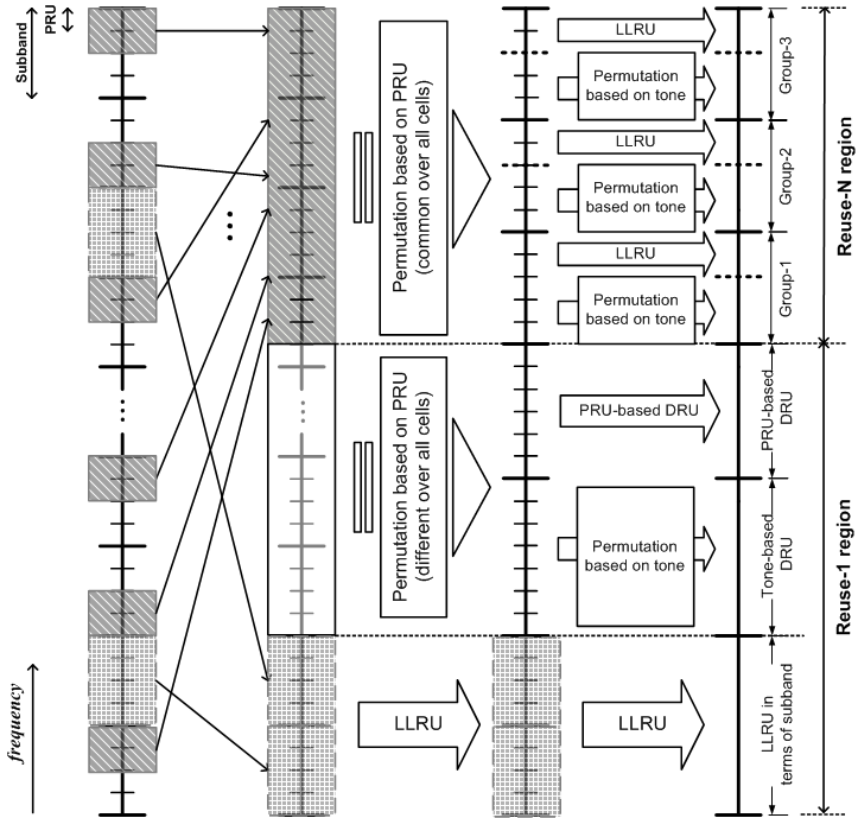


Figure 1 Illustration of the downlink subcarrier to resource ~~block~~ unit mapping

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