Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Details of SDD Section 11.6 Uplink Physical Structure**
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Re:	SDD Session 56 Cleanup, Call for PHY Details
Abstract	This is revised version of Section 11.6 of IEEE 802.16m-08/003r4. This document provides further physical layer details.
Purpose	Draft for further development of the IEEE 802.16m SDD
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The Draft IEEE 802.16m System Description Document

11 Physical Layer

11.6 Uplink Physical Structure

As described in section **Error! Reference source not found.**, the 5 ms radio frame is divided into 8 subframes. Each of the subframes can be allocated for uplink transmission. Each subframe is divided into a number of frequency partitions, where each partition consists of a set of physical resource units across the total number of OFDMA symbols available in the subframe. Each frequency partition can include contiguous (localized) and/or non-contiguous (distributed) physical resource units. Each frequency partition can be used for different purposes such as fractional frequency reuse (FFR). Figure 1 illustrates the uplink physical structure in the example of two FFR groups with FFR group 2 including both localized and distributed resource allocations.

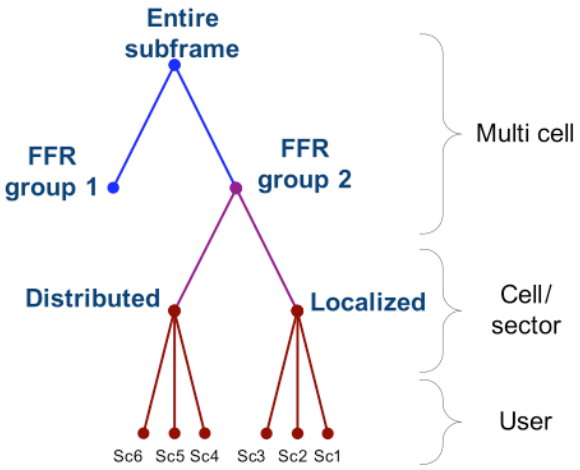

Figure 1 Example of uplink physical structure

11.6.1 Physical and Logical Resource Unit

A physical resource unit (PRU) is the basic physical unit for resource allocation that comprises Psc consecutive subcarriers by Nsym consecutive OFDMA symbols. Psc is 18 subcarriers and Nsym is the number of OFDMA symbols depending on the subframe type. A logical resource unit (LRU) is the basic logical unit for distributed and localized resource allocations and its size is Psc*Nsym subcarriers for data transmission. For control channel/message transmission, the size of LRU should be the same as that of data transmission and multiple users are allowed to share one control LRU. The LRU includes in its numerology the number of pilots that are used in a PRU, and may include control information. So, the effective number of data subcarriers in an LRU depends on the number of allocated pilots and control channel presence.

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11.6.1.1 Distributed Resource unit

The distributed resource unit (DRU) can be used to achieve frequency diversity gain. The DRU contains a group of subcarriers which are spread across the distributed resource allocations. The size of the DRU equals the size of the LRU for distributed allocations. The minimum unit for forming the DRU is a tile. *T* different types of tiles are defined, where *T* is 1. The minimum unit for forming the UL DRU is a UL tile; the UL tile sizes are $6xN_{sym}$, where N_{sym} depends on the subframe type.

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11.6.1.2 Localized Resource unit

The localized resource unit (LLRU) can be used to achieve frequency-selective scheduling gain. The LLRU contains a group of subcarriers which are contiguous across the localized resource allocations. The size of the LLRU equals the size of the LRU for localized allocations, i.e., Psc subcarriers by Nsym OFDMA symbols.

11.6.2 Subchannelization and Resource mapping

11.6.2.1 Basic Symbol Structure

The subcarriers of an OFDMA symbol are partitioned into $N_{g,left}$ left guard subcarriers, $N_{g,right}$ right guard subcarriers, and N_{used} used subcarriers. The DC subcarrier is not loaded. The N_{used} subcarriers are divided into PRUs. Each PRU contains pilot and data subcarriers. The number of used pilot and data subcarriers depends on the type of resource allocation, i.e., distributed or localized resource allocations.

11.6.2.2 Uplink Subcarrier to Resource Unit Mapping

The main features of resource mapping include:

1. Support of localized resource unit (LLRU) and distributed resource unit (DRU) in an FDM manner.
2. DRUs comprise multiple tiles which are spread across frequency partitions to get diversity gain.
3. FFR can be applied in UL.

Based on the main design concepts above, the UL subcarriers to resource unit mapping process is defined as follows and illustrated in Figure 2:

1. First-level or outer permutation is applied to the PRUs in the units of N1 and N2 PRUs, where N1=4 and N2=1. Direct mapping of outer permutation can be supported.
2. Distributing the reordered PRUs into frequency partitions.
3. The frequency partition is divided into localized (LLRU) and/or distributed (DRU) resources for each resource. Using sector specific permutation can be supported; directly mapping of the resources can be supported for localized resource. The sizes of the distributed/localized resources are flexibly configured per sector. Adjacent sectors do not need to have same configuration of localized and diversity resources.
4. The localized and distributed groups resources are further mapped into 1 LRUs. For the LLRU resources, the mapping is direct. For the DRU resources, a tile or hopping permutation is carried out for permuting or hopping the tiles of the distributed groups.

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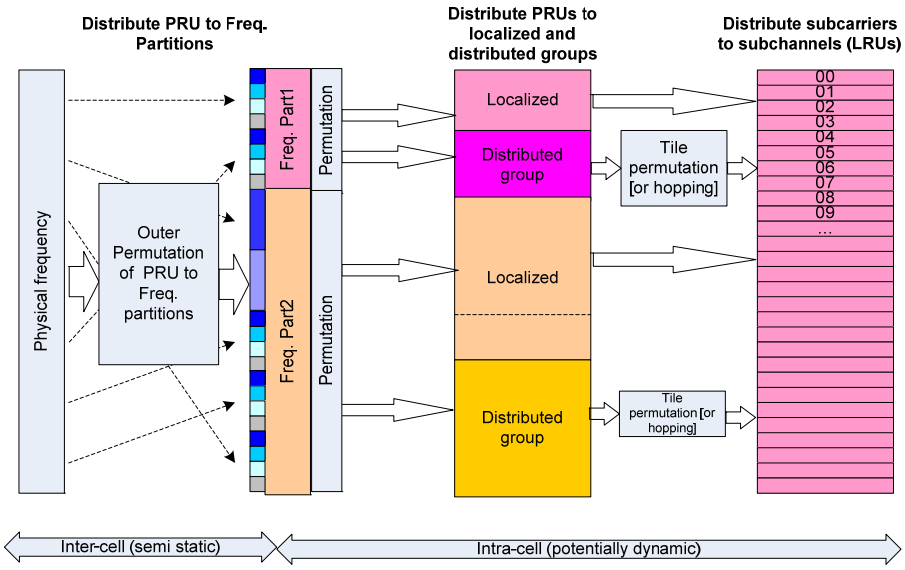

Figure 2

11.6.2.3 Subchannelization for UL Distributed Resource

A second-level permutation permutes PRUs within a frequency partition. The localized resource could be directly mapped. The tile permutation defined for the uplink distributed resource allocations spreads the tiles of the DRU across the whole allocated frequency band. The granularity of the inner permutation is equal to the minimum resource unit for forming a DRU as defined in Section 11.6.1.1.

11.6.2.4 Subchannelization for UL Localized Resource

Localized subchannels contain subcarriers which are contiguous in frequency. There is no second-level or inner permutation defined for the UL localized resource allocations. The LLRU is directly mapped to localized LRU within each frequency partition. Precoding and/or boosting applied to the data subcarriers will also be applied to the pilot subcarriers.

Uplink LLRUs frequency allocations can match that of downlink LLRUs such that channel reciprocity traits can be exploited.

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11.6.3 Pilot Structure

The transmission of pilot subcarriers in the uplink is necessary for enabling channel estimation, measurement of channel quality indicators such as SINR, frequency offset and timing offset estimation, etc. The uplink pilots will be dedicated to localized and distributed resource units and will be precoded using the same precoding with the data subcarriers of the resource allocation. The pilot structure is defined for up to 4 Tx streams with

orthogonal patterns.

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Pilot patterns shall have a mode which enables active interference supression algorithms to be employed. This includes:

- Pilot locations fixed within each DRU and LRU
- Pilot sequences with low cross correlation

The pilot pattern may support variable pilot boosting. The boosting values are TBD. The UL pilot patterns for LRU is the same as DL LRU as shown in Fig. X. The UL pilot patterns for LRU is shown in Fig. Y.

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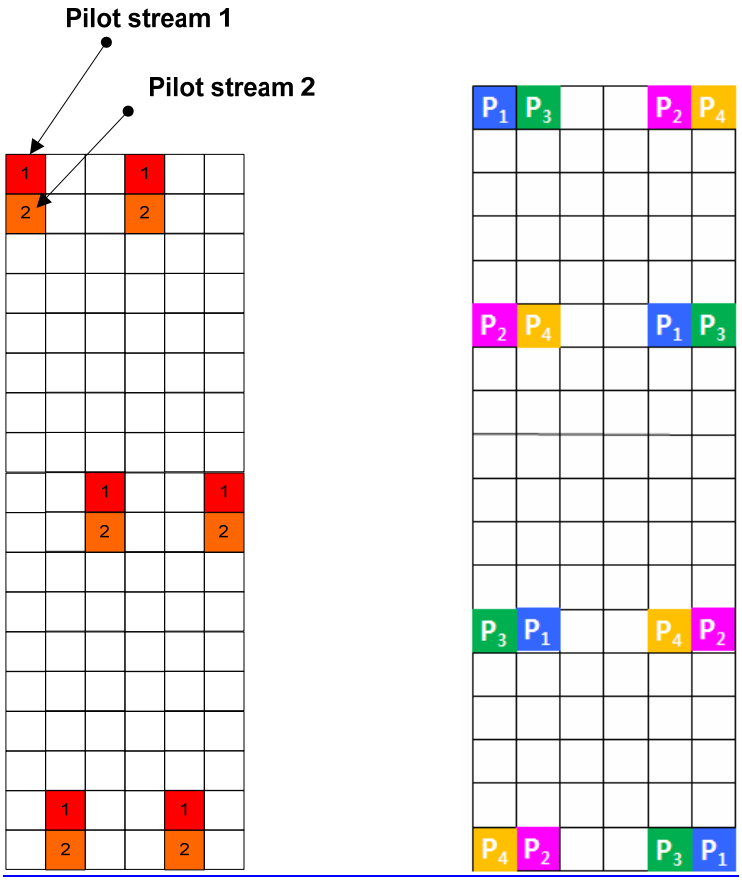

Fig. X: UL LRU pilot patterns for 1, 2 steams and 4 streams

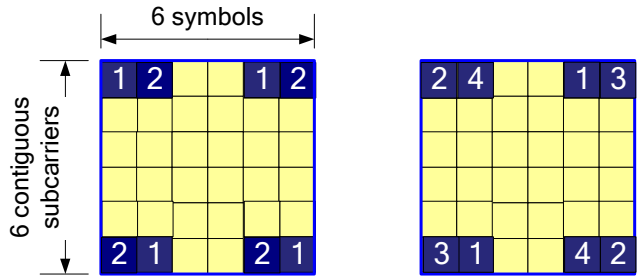

Fig. Y: UL DRU pilot patterns for 1, 2 steams and 4 streams

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11.6.4 Uplink Physical Structure for Legacy Support

The 802.16m uplink physical structure supports both FDM (frequency division multiplexing) and TDM (time division multiplexing) with the legacy system. When the legacy system operates in the PUSC mode, then the type of multiplexing is TBD. If the legacy system operates in the AMC mode, then the uplink resources for the legacy and the 802.16m system are multiplexed using FDM or TDM.

In supporting the legacy system, the first 3 OFDM symbols of a UL subframe is reserved for legacy control channels using PUSC. The remaining 3 OFDM symbols of this UL subframe is combined with the following UL subframe to form a UL subframe with 9 OFDM symbols as shown in the following figure.

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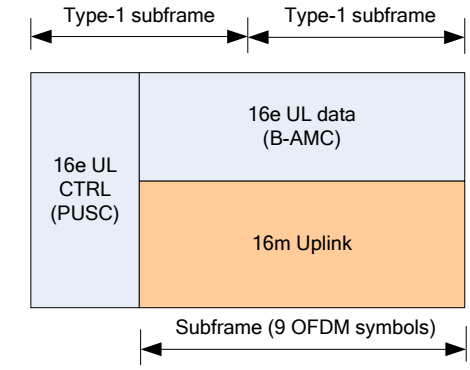

Figure 3