Proposal for IEEE 802.16m Uplink Physical Resource Allocation Unit in Green-field

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Venue:

IEEE 802.16m-08/016, “Call for Contributions on Project 802.16m System Description Document (SDD)”.

Target topic: “Uplink Physical Resource Allocation Unit (Resource blocks and Symbol Structures)”.

Base Contribution:

None

Purpose:

To be discussed and adopted by TGm for the 802.16m SDD

Scope

- This contribution proposes a new resource allocation unit and channelization for green-field design in IEEE 802.16m uplink

Uplink PHY Resource Unit

- UL basic PHY resource unit (PRU) is defined as the basic physical resource allocation unit for both UL localized resource allocation (LRA) and distributed resource allocation (DRA). The LRA and DRA could be either multiplexed in a FDM manner in the same subframe, or in a TDM manner in different subframes.
- UL basic PRU shall be a frequency-time block of 18 subcarriers in 6 symbols.
  - 18*6 is what we proposed for DL basic PHY RU (C80216mDL_PHY-08_037.doc) and is compatible to the mandatory 16e AMC structure.
- The UL logical resource unit (LRU) is a basic logical unit for resource allocation having the same size as the UL PRU.
- In case of LRA, the UL PRU has the same pilot structure as DL PRU and is directly mapped to localized LRU.
- In case of DRA, each UL PRU will be divided to several subPRUs, in which different pilot structures are designed. A distributed LRU for bandwidth allocation contains multiple subPRUs spreading over the whole frequency band to gain frequency diversity.
- Below two kinds of subPRU are defined to support data channel and control channel transmission respectively.

Uplink subPRU1: for data channel

- The uplink subPRU1 is defined as a freq-time block of 6 subcarriers in 6 symbols, thus one UL PRU consists of three subPRU1.
- Defining a subPRU size of 6x6 has the following advantages
  - To support LRA and DRA in FDM
  - Lower pilot overhead for proper channel estimation. Generally, the pilot overhead increases with the decrease of block size.
  - 3 subRPUs in a distributed LRU fully exploits frequency diversity gain
- Below it shows the detailed pilot pattern design for different scenarios.
  - Single user
    - SISO
    - MIMO
  - Two users for virtual MIMO
    - One Tx antenna per user
    - Two Tx antenna per user
- Note: the pilot overhead is defined with respect to each Tx antenna.

Uplink subPRU1: for data channel

- Single user
  - The subPRU1 structure with pilot pattern for SISO case is shown in the figure 1.
  - The subPRU1 structure with pilot pattern for MIMO case is shown in the figure 2. D1 and D2 denotes the pilot from the Tx antenna-1 and Tx antenna-2 respectively.
  - The pilot overhead is 1/9.
  - Note: in case of irregular subframe, the first or last symbol may be used for other purpose, e.g. TTG/RTG, periodic ranging and sounding.

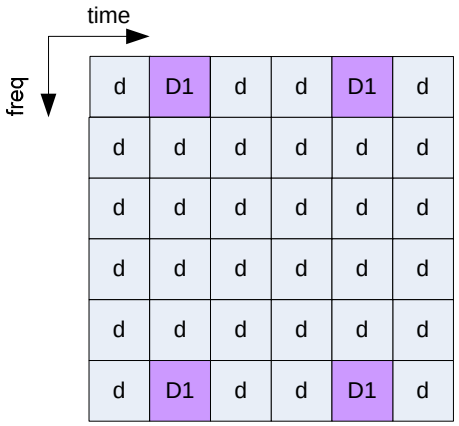


Figure 1: UL subPRU1, single user SISO case

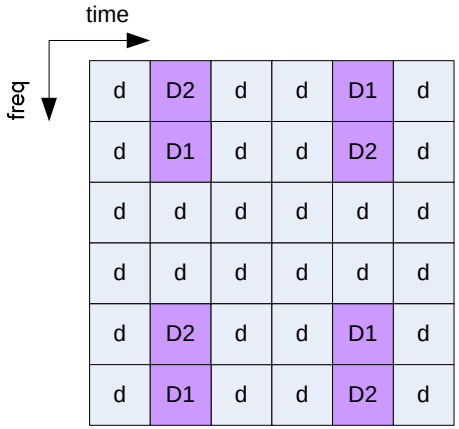


Figure 2: UL subPRU1, single user MIMO case

Uplink subPRU1: for data channel

- Two users
  - In case of one Tx antenna for each user, the subPRU1 structure with pilot pattern is shown in the figure 3.
  - In case of two Tx antennas for each user, the subPRU1 structure with pilot pattern is shown in the figure 4.
  - Color distinguishes different users in case of UL MIMO. And D1 and D2 denotes the pilot from the Tx antenna1 and Tx antenna2 respectively.
  - Note: for irregular subframe, the first and/or last symbol may be used for other purpose, e.g. TTG/RTG, periodic ranging and sounding.

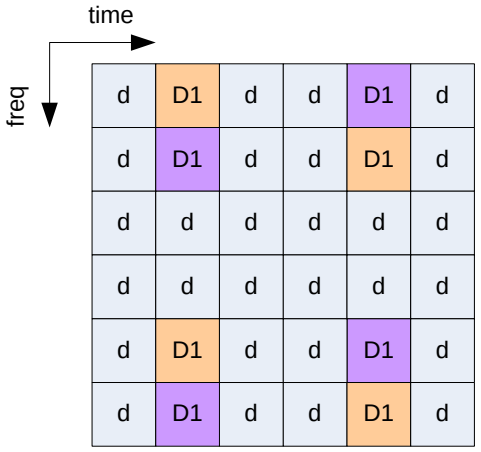


Figure 3: UL subPRU1, Two users, one Tx per user

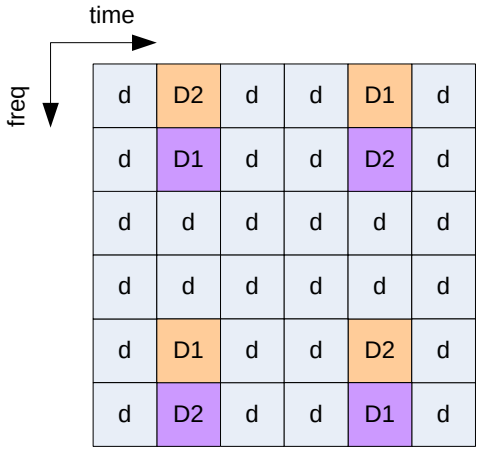


Figure 4: UL subPRU1, Two users, two Tx per user

Uplink subPRU1: for data channel

- Special case: transmission of 48 data symbols
  - The distributed LRU will be split into two half, each of which contains 18*3 subcarriers and could be assigned to one MS to transmit one 48-bit header.
  - The way of the split is shown in Figure 5 (SISO case) and Figure 6 (MIMO case).
  - Thus for MIMO case, rate matching is needed.

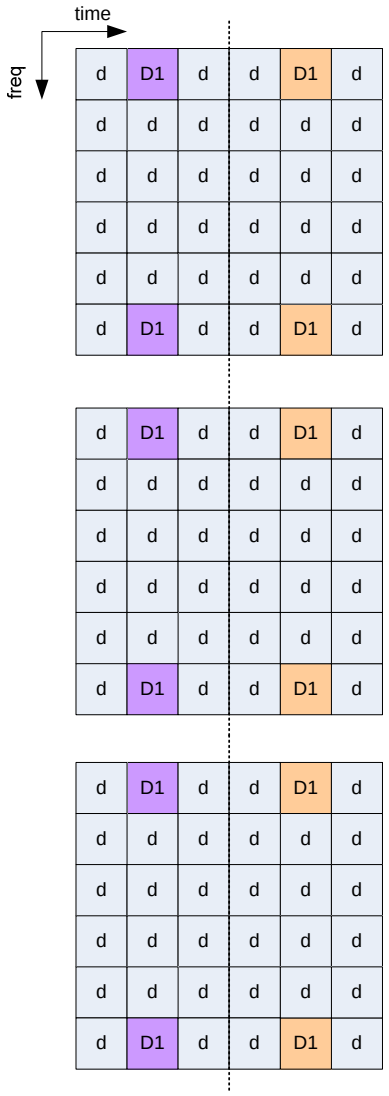


Figure 5: Special transmission for 48 data symbols, SISO case

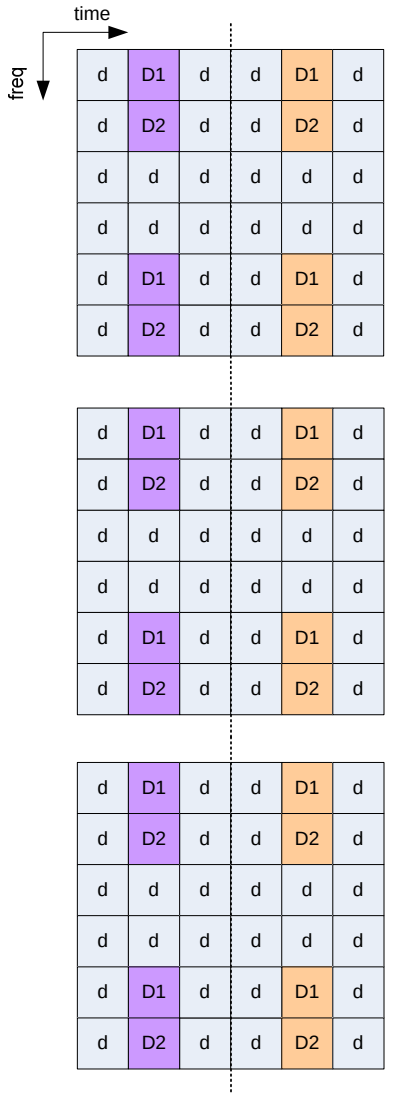


Figure 6: Special transmission for 48 data symbols, MIMO case

Uplink subPRU2: for control channel

- 1 subPRU2 has the structure of 2x3, i.e. 2 subcarriers by 3 symbols
- There are two pilots per subPRU2
- The UL subPRU2 structure for SISO case is shown in Figure 7.
- ACK/NAK channel design:
  - One ACK/NAK channel consists of three subPRU2, which are distributed in the frequency domain.
  - Thus 12 data subcarriers for one ACK/NAK channel
  - 6 ACK/NAK channels in one distributed PRU.
- The CQI channel and ranging channel design are TBD.

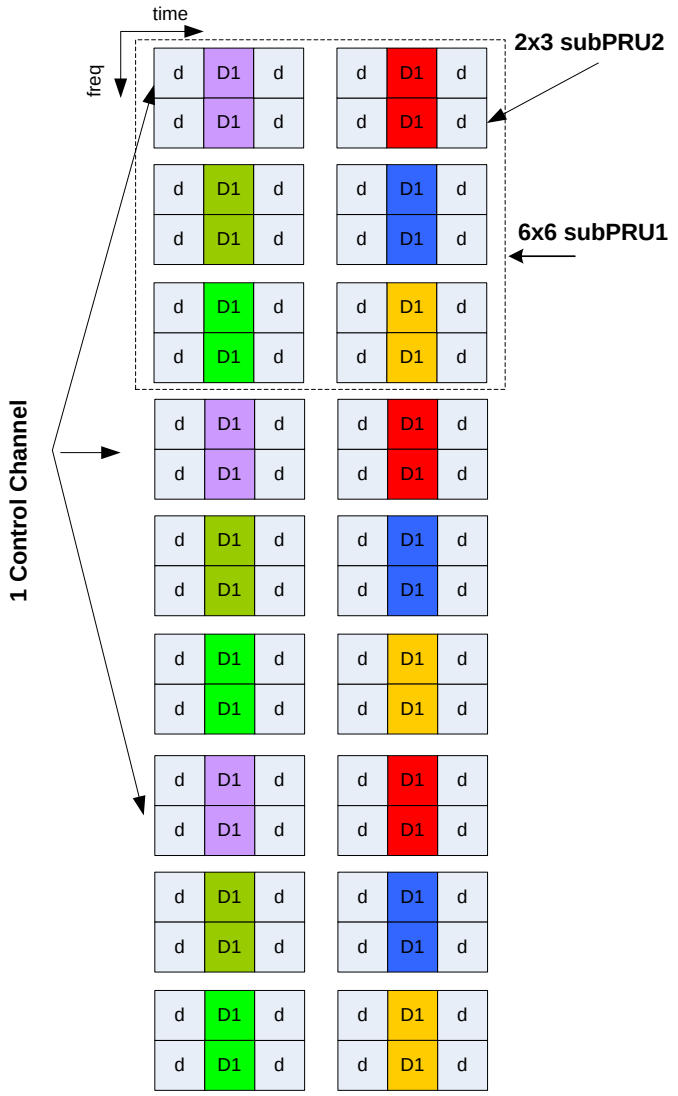


Figure 7: UL subPRU2 for control channel, SISO case

Uplink subPRU2: for control channel

- For MIMO case, e.g. two antennas per user, the UL subPRU2 structure is shown in Figure 8.
- The 1st pilot (D1) is transmitted from the 1st antenna, and the 2nd pilot (D2) is transmitted from the 2nd antenna.

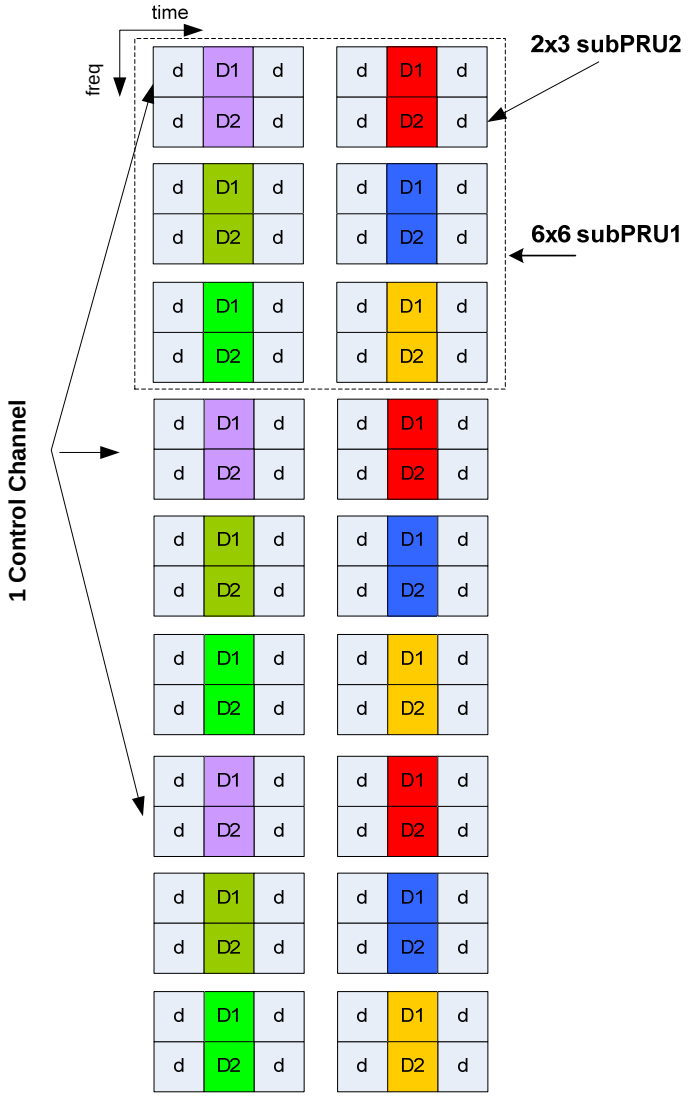


Figure 8: UL subPRU2 for control channel, MIMO case

Subchannelization and Resource Mapping

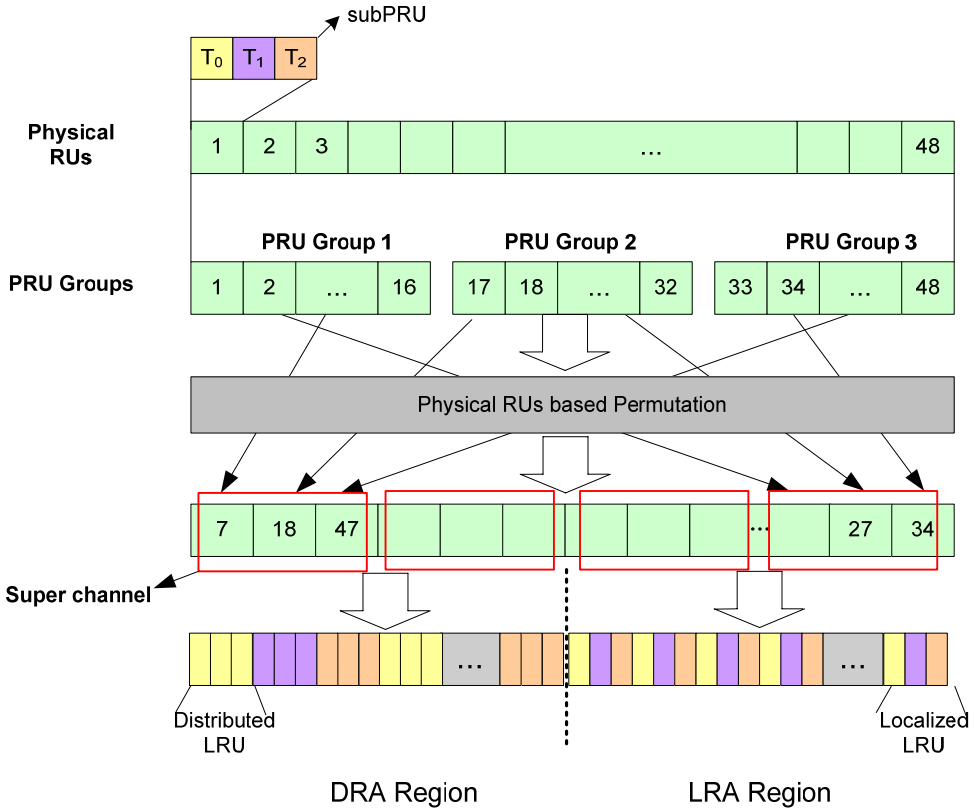
- New subchannelization design are defined for IEEE 802.16m uplink to support LRA and DRA in FDM.
- Resource mapping is on the sub-frame basis.
- The whole band is divided into LRA and DRA region, each containing a particular number of PRUs.
  - In a LRA region UL PRUs are directly mapped to localized LRU, which is equivalent to UL PRU
  - In a DRA region a distributed LRU comprises Nc subPRUs (default Nc=3) which can be spread across the entire band
- Permutation is performed to form a distributed LRU to achieve interference averaging. The permutation is based on PRUs or concatenated PRUs.

Overall Subchannelization Procedure (1/2)

- Step 1: Partition all subcarriers excluding DC and null subcarriers into PRUs, and partition each PRU into Nc subPRUs
- Step 2: Partition the entire frequency band into Nc groups of continuous PRUs
- Step 3: Permuting the resource unit groups based on PRU or concatenated PRUs and form a super channel by selecting Nc PRUs from the permutated resource unit groups
- Step 4: Selecting a group of the super channels to form an allocation for DRA region and the others are assigned for LRA region

Overall Subchannelization Procedure (2/2)

- Example: 10 MHz bandwdith and total 48 PRUs



Proposed text changes for 802.16m SDD

- Section 11.x: Uplink PHY Structure
  - Section 11.x.x: Uplink PHY Structure for Green-field
    - UL basic PHY resource unit (PRU) is defined as the basic physical resource allocation unit for both UL localized resource allocation (LRA) and distributed resource allocation (DRA) The LRA and DRA could be either multiplexed in a FDM manner in the same subframe, or in a TDM manner in different subframes.
  - Section 11.x.x.1: Physical and logical resource units
    - The UL PRU shall be a frequency-time block of 18 subcarriers in 6 symbols.
    - The UL logical resource unit (LRU) is a basic logical unit for resource allocation having the same size as the UL PRU.
    - In case of LRA, the UL PRU has the same pilot structure as DL PRU and is directly mapped to localized LRU.
    - In case of DRA a distributed LRU comprises Nc subPRUs (default Nc=3) which is block of *6* subcarriers by *6* symbols and spread across the entire band to gain frequency diversity
  - Section 11.x.x.2: Subchannelization and resource mapping
    - Insert slide 11~12.
  - Section 11.x.x.3: Pilot structure
    - New pilot pattern for subPRU1 and subPRU2 (add the figures in slides 5~9)