Project	**IEEE 802.20 Working Group on Mobile Broadband Wireless Access** **<http://grouper.ieee.org/groups/802/20/>**
Title	**Partial proposal on channel multiplexing -- Presentation**
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Re:	IEEE 802.20 Call for Proposals
Abstract	This document proposes a flexible channel multiplexing scheme for the Mobile Broadband Wireless Access Systems.
Purpose	For consideration and adoption as a feature supported by 802.20 standard
Notice	
Release	
Patent Policy	

Partial Proposal on Channel Multiplexing

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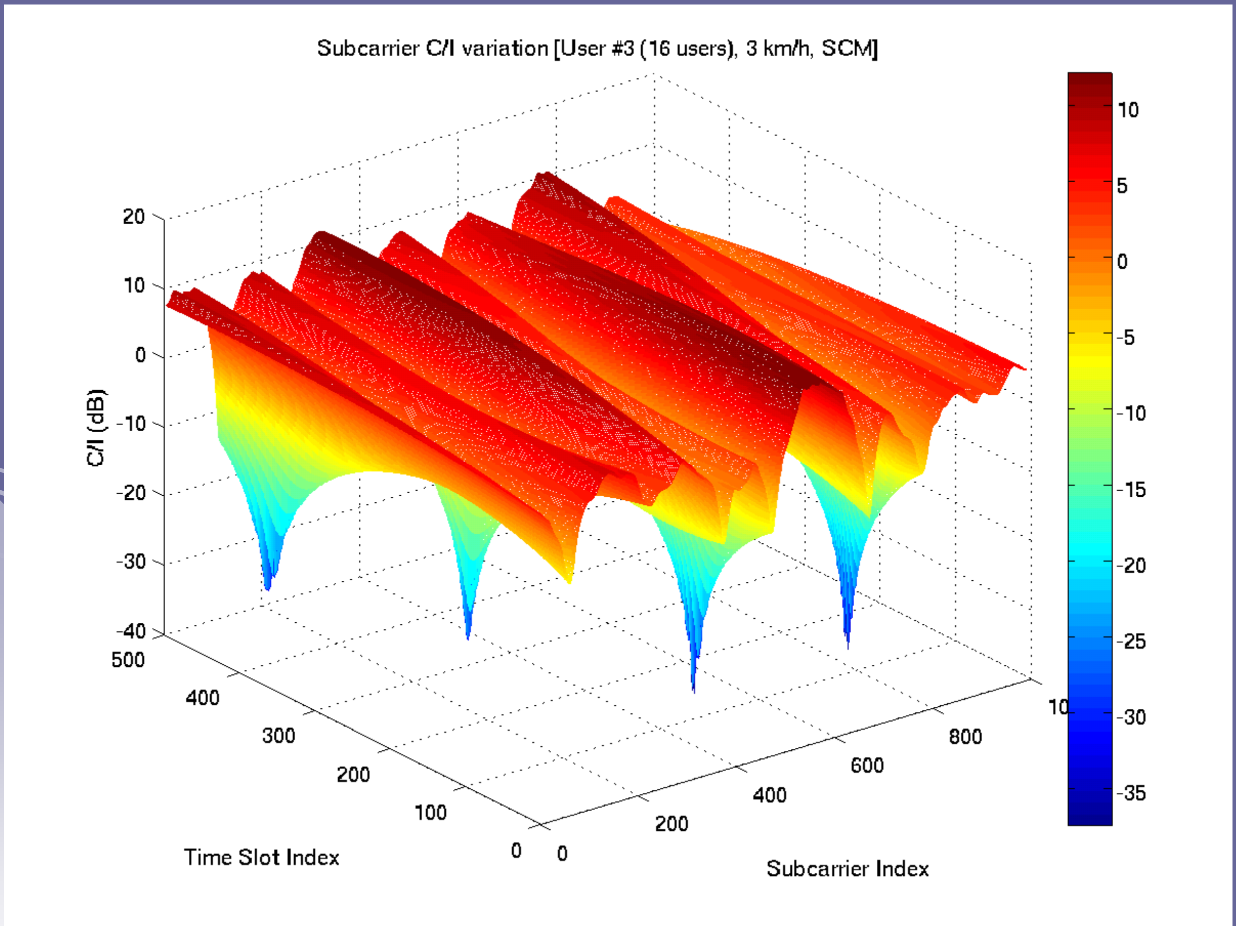
Introduction

- Propose a scheme to multiplex different types of user channels flexibly in an OFDMA mobile cellular system
  - Contiguous subcarrier channel for subband scheduling
  - Distributed subcarrier channel for diversity gain
- Simultaneous support of these two types of channels was related to one of the open issues from Letter Ballot 1 and 2 Comments
- Previous proposals and the new 3GPP2 Ultra Mobile Broadband (UMB) standard support similar schemes [1], [2], [3]

Mobile Cellular Channel Characteristics

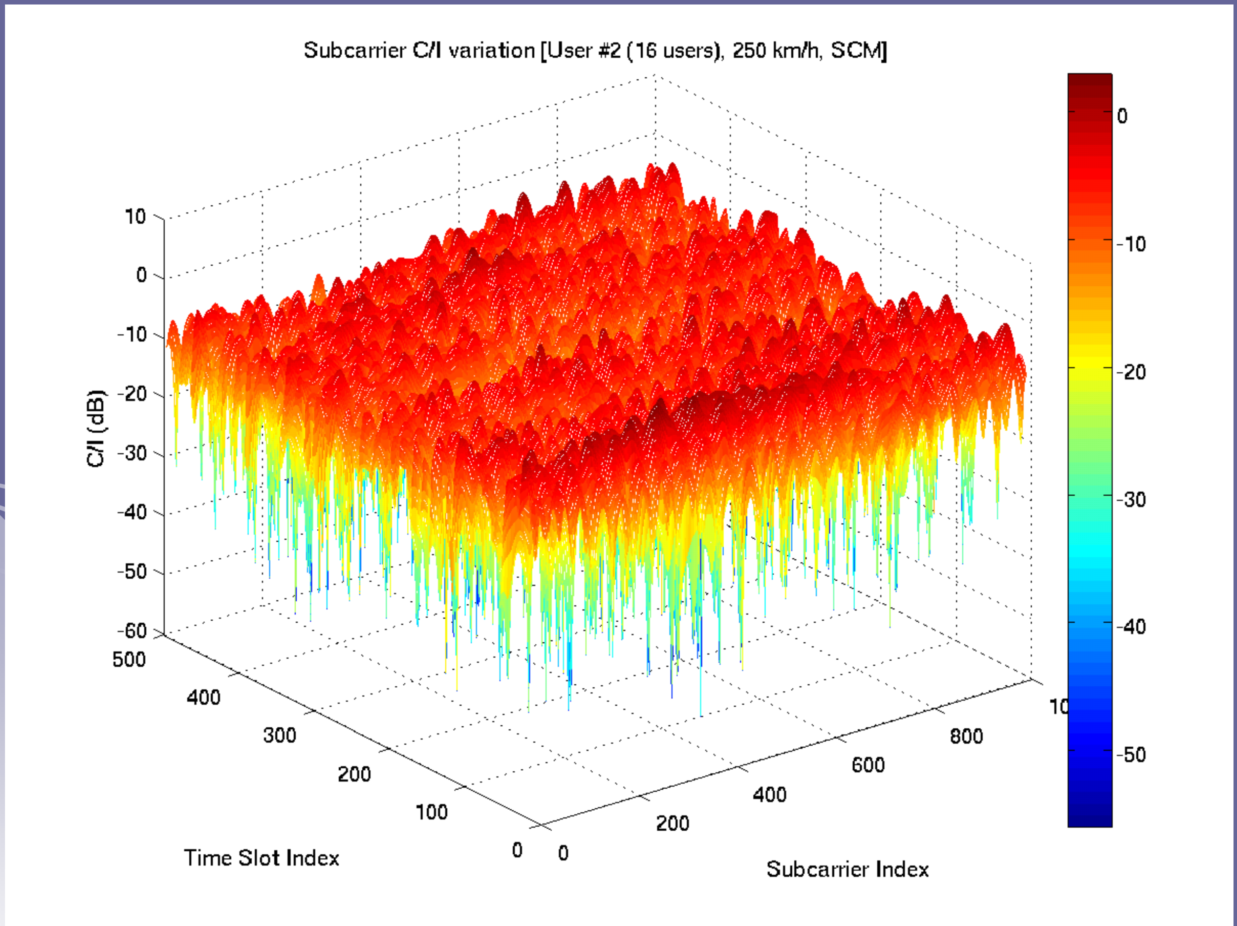
- Users may be located in a poor geometry or with high mobility
  - Not a specific subband that has significantly better C/I than others
  - At high mobility, the channel quality feedback will become out-of-date at the time of scheduled transmission
  - May not be benefited from subband scheduling
  - May be more beneficial to have transmission over subcarriers that span across the entire bandwidth
    - To maximize frequency diversity gain
- In contrast, some user channels may be highly frequency selective
  - Advantageous to have the user transmission over the subbands that have better C/I

Subcarrier C/I Characteristics - Example for Slow mobility



- 3 km/h
- Spatial Channel Model [1] [2]
- 16 users/sector

Subcarrier C/I Characteristics Example for High Mobility



- 250 km/h
- Spatial Channel model
- 16 users/sector

OFDMA Channel Multiplexing

- Based on the channel characteristics , OFDMA channels can be classified into two different types in general:
  1. Contiguous Subcarrier Channel (BRCH)
     - Consists of a contiguous block of physical subcarriers
     - Allocated channel unit usually in the form of a tile because of the contiguity in time and frequency
     - Allocation based on frequency subband scheduling
  2. Distributed Subcarrier Channel (DRCH)
     - Consists of subcarriers that are distributed across the system bandwidth
     - Advantageous for frequency diversity gain

Channel Structure in MBTDD/FDD

- Forward Link
  - Symbol Hopping mode
    - Similar to distributed subcarrier channels
  - Block Hopping mode
    - Tiles of fixed size: 16 subcarriers by 8 symbols (slots)
    - Three different pilot patterns
      - 18 or 24 pilot tones per tile
    - Similar to contiguous subcarrier channels
- Reverse Link
  - Block hopping
    - Tiles of fixed size: 16 subcarriers by 8 symbols (slots)
    - Two different pilot patterns
      - 18 or 24 pilot tones per tile

Proposed Design

- Common primary pilots with Staggering
- For multiple transmit antenna systems, additional pilot tones can be allocated in the adjacent time slots on the same pilot subcarriers
- DRCH
  - Users with poor geometry or high mobility
  - Start with the set of subcarriers in immediate adjacency to the set of primary pilot subcarriers
    - For improved channel estimation accuracy
  - Number of DRCH allocated based on number of users meeting certain criteria
    - e.g., poor geometry, high mobility

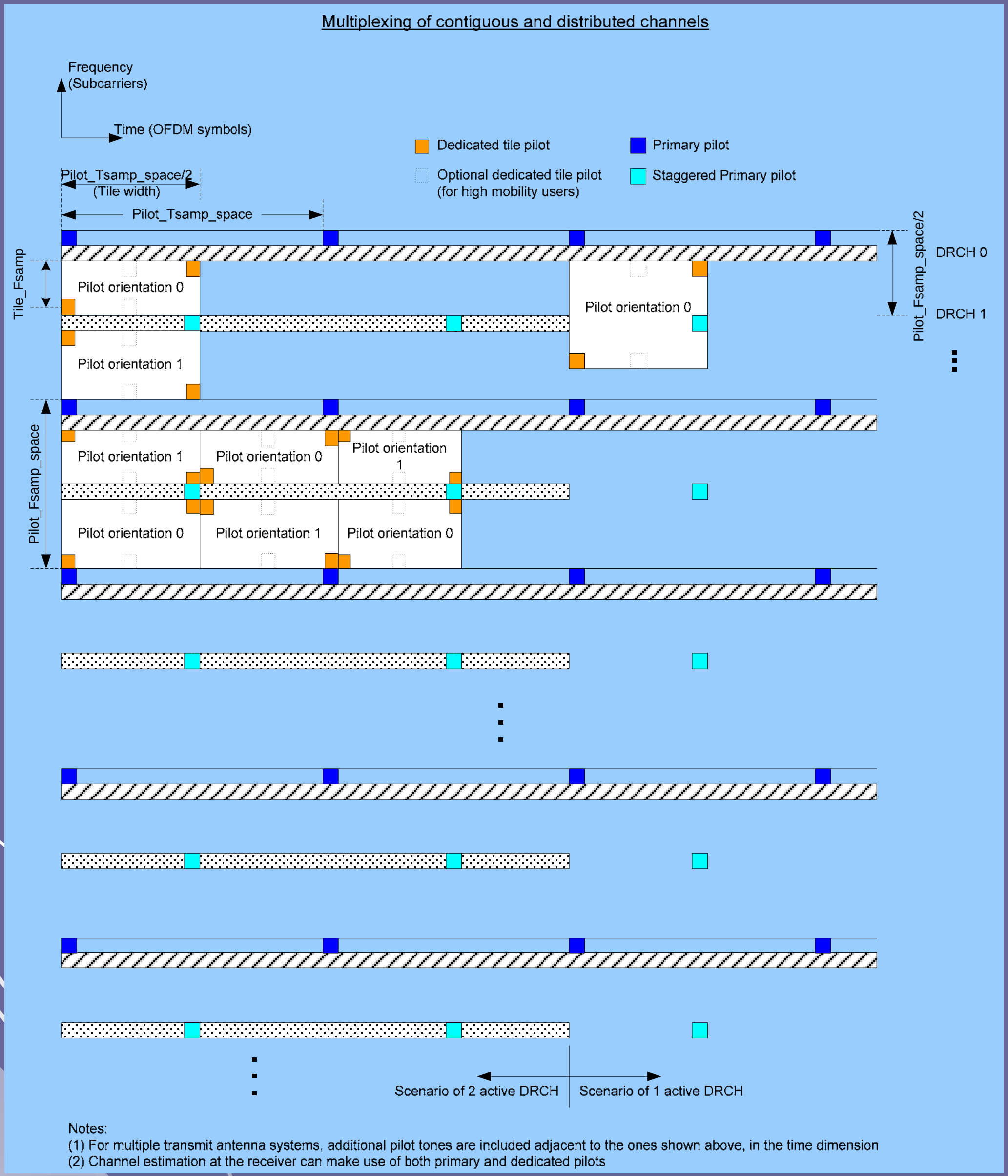
DRCH

- DRCH assignment Rule
  - First DRCH (DRCH0) in the frame - allocated to the set of subcarriers immediately below those that carry the primary pilot tone;
  - Second DRCH (DRCH1) - allocated to the set of subcarriers that carry the staggered pilot tone;
  - Additional DRCH - allocated to the set of subcarriers immediately following DRCH0 or DRCH1, alternatively.
- Subcarrier location can be easily identified by DRCH channel index "n"
- Define:
  - N_primary_pilot = Index of the first primary pilot subcarrier
  - Pilot_SC_spacing = Spacing between primary pilot subcarriers
- Thus:
  - Index of the first subcarrier allocated to DRCHn

    = N_primary_pilot + n, n even;

    = N_primary_pilot + Pilot_SC_spacing/2 + n, n odd

Channel Multiplexing Scenario

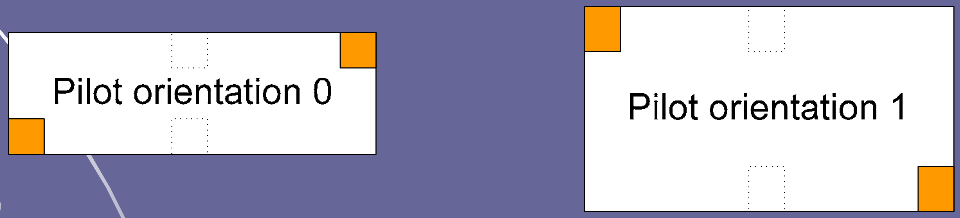


BRCH

- For users with frequency selective channels
  - Exceptional channel quality at specific portions of the spectrum
  - A set of contiguous subcarriers from that subband may be allocated
  - Higher spectral efficiency and link reliability
  - Resource (Time, Frequency) allocation units are in the form of tiles
    - Contiguous time slots (symbols)

Tile Structure

- Tile Structure
  - Flexible in frequency subcarrier dimension
    - Dependent on the number of available subcarriers after DRCH assignment
  - Pilot tones located at diagonally opposite corners
  - Two possible pilot orientations
  - Optional pilot tones can be included at the mid-point of the tile edge
  - Smaller tiles can be aggregated into bigger tiles
  - Orientation of pilots can be chosen to support certain types of MIMO modes if desirable



BRCH Addressing

- Number of contiguous subcarriers available for a tile varies depending on the number of DRCH allocated
- For BRCH m, number of frequency subcarriers

  = Pilot_SC_spacing/2 – n mod 2, m even;

  n: number of DRCH assigned

  = Pilot_SC_spacing/2 – (n-1) mod 2, m odd

Forward Link Control Channel

- Control information needs to be received by all users in the coverage area of a sector
- Forward link control channel to be transmitted in the time slots (symbols) using the same subcarriers as the common primary pilot channel
- An additional forward link control channel to be transmitted in time slots (symbols) using the same subcarriers as the staggered pilots
  - if necessary
- Distributed subcarriers to take advantage of frequency diversity gain

Channel Quality (C/I) Measurement Feedback

- C/I feedback by access terminals (AT)
  - Mean and standard deviation of pilot C/I measurements
    - Taken across all pilot subcarriers (SC) in the frequency dimension, i.e., for measurements taken within the similar time frame
  - The best N pilot C/I measurements, including the indices of the pilot SC
    - Value of N: parameter to be configured at the access network
    - Can be broadcasted as part of the SystemInfo through the primary broadcast control channel, pBCH0
    - Alternatively, N may also be included as part of the information transmitted in the forward link shared control channel
  - AT shall feedback a “maximum” of N pilot C/I measurements, including the pilot SC indices, that are larger than the computed mean across all the pilot SC, in the C/I report, as the ‘Delta’ above mean
    - Let $(C/I)_x$ = Measurement of pilot SC x
      - $Delta\_x = (C/I)_x - (C/I)_{mean}$

Support of Frequency Hopping

- Frequency Hopping
  - Both hopping and non-hopping modes are supported
  - Hopping mode
    - Mapping between the logical subcarriers and physical subcarriers changes over time according to a pre-determined sequence
    - Logical channel structure as described earlier remains unaffected
    - Supported by MBTDD/FDD (802.20 standard draft)
  - Non-hopping mode
    - Frequency planning required to place pilot subcarriers at fixed offset from those in adjacent sectors

Intercell Interference Control

- Intercell interference can be minimized in the proposed channel multiplexing structure
- Distributed subchannels (DRCH) may be transmitted at the maximum power, P_{max}
  - Users are typically at poor geometry (low C/I)
- Band scheduling subchannels (BRCH) may be transmitted at lower power
  - Users are typically at better geometry (high C/I)
  - Initial transmission at a lower power, P_o
  - With each HARQ re-transmission, the transmit power can be increased by a fixed step, ΔP:
    - $P_{max} = P_o + N_{max} * \Delta P$
    - N_{max}: maximum number of HARQ re-transmissions

Comparison with MBTDD/MBFDD

- Channel Structure
  - Current 802.20 standard draft (MBTDD/FDD) does not support symbol hopping and block hopping users simultaneously in the same cell site
  - Our proposal supports both types of users simultaneously in the same cell site
  - Both hopping or non-hopping modes are supported
- Tile format and pilot structure
  - Current 802.20 standard draft supports a fixed tile size of 16 subcarriers x 8 OFDM symbols, with 18 or 24 dedicated pilot tones per tile
  - Our proposal supports flexible tile size, with 2 pilot tones per tile
    - Can be increased to 4 pilot tones if necessary
    - Much lower overhead especially for SISO users
    - Enables channel estimation using a combination of common, primary (and staggered) pilots and dedicated pilots on the tile

Major Changes Required

- Include additional tile formats for the forward link, Section 9.3.2.6.2.3.4 F-DPICH Format 3; modify Table 70, Section 7.4.6.3.1.2
- Include additional tile formats to the RL, Section 9.4.1.6.1.1.3; modify Table 70, Section 7.4.6.3.1.2
- Include an additional field (1 bit) in the link assignment block to indicate which type of channel structure is assigned
- Assignment message include channel index; with information about the number of assigned DRCH, in the case of BRCH assignment
- In the case of new tile format, include one bit for the pilot orientation, and an additional bit to indicate if the optional pilot tones are used

Conclusion

- Current proposal supports an MBWA system that can optimize user and system throughput performance by using channel knowledge
- In the absence of channel knowledge, user and system can benefit from frequency diversity gain
- An improvement over the design as described in the current version of the standard draft
- New tile structure which is flexible in size with lower pilot overhead
  - SISO users can be supported efficiently, as most of the dedicated pilot tones in the adopted tile design are redundant for SISO users
  - Beneficial for bursty traffic that may consist of small data packets, as the granularity of resource assignment is increased

References

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5. ‘3GPP, TR25.996, “Spatial Channel Model for Multiple Input Multiple Output (MIMO) [‘Spatial Channel Model Text Description’, SCM-135, 3GPP/3GPP2 Spatial Channel Model Ad-Hoc]
6. ‘Overview of the Spatial Channel Model developed in 3GPP-3GPP2’, C802.20-04/79, Nov 15, 2004.