Enhanced MIMO support for Cellular OFDMA Systems using Midambles

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Source:

Sriram Mudulodu, K. Giridhar, Erik Lindskog, Kamlesh Rath, Aditya Agrawal, Bob Lorenz, Babu Mandava, A. Paulraj

Voice: +1-408-387-5019
E-mail: smudulodu@beceem.com

Beceem Communications, Inc.

Sung-Eun Park, Wonil Roh, Seung-Hoon Choi, JeongTae Oh, Chan-Byoung Chae, Kyunbyoung Ko, Hongsil Jeong, Sung-Ryul Yun,
Seungjoo Maeng, Panyuh Joo, Jaeho Jeon, Jerry Kim, Soonyoung Yoon

Voice: +82-31-279-5249
E-mail: se.park@samsung.com

Samsung Electronics Co., Ltd.

Yossi Segal, Itzik Kitroser, Yi gal Leiba, Eli Shasha, Zion Hadad

Voice: +972-3-9528440
E-mail: yossis@runcom.co.il

Runcom Technologies Ltd.

Wen Tong, Peiying Zhu, Jianglei Ma, Ming Jia, Hang Zhang,
Mo-Han Fong

Voice: (613)-763-1315
E-mail: wentong@nortelnetworks.com

Nortel Networks

Jason Hou, Jing Wang, Sean Cai, Dazi Feng, Yonggang Fang

Voice: 858-554-0387
E-mail: jhou@ztesandiego.com

ZTE San Diego Inc.

Anand Dabak, Srinath Hosur, David Magee

Voice: 
E-mail: hosur@ti.com

Texas Instruments

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Purpose: Adoption of proposed changes into P802.16e-D5

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August 31, 2004
Introduction

• Goal: To improve channel estimation and tracking in MIMO OFDMA systems
• The preamble is transmitted from a single antenna in the current draft for 802.16e
• First symbol of MIMO zone of the DL sub-frame
• Simple PN sequence, low PAPR, good cross-correlation property
• Support for various FFT sizes and 2,3,4 Tx antennas in both FUSC and PUSC
• Purely optional and no impact on SISO SS
Midamble Structure

- FUSC or optional FUSC
  - The transmit antennas use non-overlapping subcarriers
  - DC carrier is nulled prior to transmission.
- Number of BS antennas is 2: Antenna n transmits on subcarriers, $-(N_{\text{used}}/2)+n+2k$
- Number of BS antennas is 3 or 4: Antenna n transmits on subcarriers, $-(N_{\text{used}}/2)+n+4k$

where:

- $N_t$ is the number of transmit antennas
- $n$ is the antenna index $1, \ldots, N_t - 1$
- $k$ is the sub-carrier running index
Midamble Structure

• Example: $N_t = 4$

Figure xxxx. Midamble FUSC structure (frequency domain)
Midamble Structure

- **PUSC**
  - The subchannel permutations and grouping remains same as for the data subchannel
  - Instead all the subcarriers are used as pilots.

- **Midamble_Carrier_Set**: 
  
  $$-(N_{\text{used}}/2) + n + N_t\ k$$

  where:
  - $N_t$ is the number of transmit antennas
  - $n$ is the antenna index 1, ..., $N_t$-1
  - $k$ is the sub-carrier running index
Midamble Structure

• Example: $N_t = 4$

Figure yyyy. Midamble PUSC structure (frequency domain)
Midamble Sequence

- FUSC or optional FUSC

\[ q_{ID_{cell}}[m] = \begin{cases} 
R(8 \cdot \left\lfloor \frac{m}{9} \right\rfloor + m \mod 9), & \text{where } m \mod 9 = 0,1, \ldots, 7 \\
T(\left\lfloor \frac{m}{9} \right\rfloor), & \text{where } m \mod 9 = 8
\end{cases} \]

\[ m = 0,1, \ldots, \frac{N_{\text{used}}}{2} - 1 \]

\[ R_1(r) = H_{128}(ID_{cell} + 1, \prod_{r=1}^{L}(r \mod 128)), \quad r = 8 \cdot \left\lfloor \frac{m}{9} \right\rfloor + m \mod 9 = 0,1, \ldots, N_r - 1 \]

\[ R_2(r) = B_{ID_{cell}+1} g_{\Pi(r)}, \quad r = 8 \cdot \left\lfloor \frac{m}{9} \right\rfloor + m \mod 9 = 0,1, \ldots, N_r - 1 \]

- The sequence \( T(k) \) is determined by IDcell and should be chosen to achieve low PAPR
Midamble Sequence

• PUSC
  – The midamble sequence for PUSC shall be obtained from the corresponding sequence used in the FUSC or optional FUSC for the relevant FFT size and number of antennas.

  – For PUSC, however, all the used subcarriers shall further be clustered and divided into different segments as in the data traffic region