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모바일 IPTV 서비스를 위한 Single Frequency Network에서의 효율적인 MBS Zone 구성

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An Efficient Method of MBS zone Configuration with Single Frequency Network for Mobile IPTV Services

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요 약

SFN (Single Frequency Network) 환경에서의 MBS (Multicast and Broadcast Service) 는 현재 IEEE 802.16m 의 Working Group에서 현재 규격화 작업이 진행되고 있다. SFN 환경에서는 매크로 다이버시티 (Macro Diversity) 성능 이득을 위해 MBS zone이 구성될 수 있다. MBS 서비스를 할 때, 여러 셀 (Cell) 에 있는 각각의 기지국들이 중심 셀의 여러 위치에 있는 단말들에게 같은 컨텐츠를 보낼 때 각각의 다른 위치에 있는 단말에서 얻을 수 있는 매크로 다이버시티 성능 이득을 BER (Bit Error Rate) 컴퓨터 시뮬레이션을 통하여 알아본다. 본 논문에서는 단말의 위치에 따른 MBS zone을 구성하는 효율적인 방법을 제안할 것이다.

Key Words : MBS, SFN, IEEE802.16e, Mobile-WiMAX, Mobile-IPTV

ABSTRACT

Multicast and broadcast service (MBS) in a single frequency network (SFN) is being standardized in the IEEE 802.16m working group. In an SFN environment, the MBS zone must be configured for performance enhancement with macro diversity. Therefore, we determine the macro-diversity gain through the bit error rate performance when several base stations in a cell transmit the same data content to a mobile station for MBS service (for example, mobile IPTV services). We determined that the location of the mobile stations should be considered when configuring an MBS zone.

Ⅰ. Introduction

Globally, many companies have come out with IPTV products that converge telecommunications and broadcasting . In the USA, Japan, Italy and China, many companies are driving IPTV services. However, mobile IPTV is still under creationon the basis of Mobile-WiMAX (IEEE802.16e), but it has extended the market place by providing services to portable wireless terminals through a settopbox (STB) receiving IPTVservices.

It is possible to multicast and broadcast services in a conventional access network for mobile IPTV. Thus, MBS is a typical multicast and broadcast service in IEEE 802.16e.

Orthogonal frequency division multiplexing (OFDM) has recently been applied widely in wireless communication systems due to its advantages such as robustness to multi-path delays [1-4]. Therefore, in this paper, we analyze the bit

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error rate (BER) performance according to the location of the mobile station (MS) in a cell through computer simulation in a single frequency network (SFN) environment, which is similar to a multi-path environment.

In section 2.1, the concept of MBS zone is given. Section 2.2 represents the method of channel estimation and interpolation, as well as a detailed description of the simulation environment. Section 3 delivers the simulation results and conclusions of this paper.

Ⅱ. Mbs Zone Configuration

2.1 MBS in IEEE 802.16e

Different CIDs or different SAs may be used in different regions for the same multicast and broadcast service flow. A multicast and broadcast zone identifier (MBS_ZONE) is used to indicate the region through which a CID and SA for a broadcast and multicast service flow are valid. A BS that supports a multi-BS access MBS shall advertise the MBS_ZONE in a downlink channel descriptor (DCD) message[5].

To increase the receiving performance, the MBS transmission in a group of BSs should be synchronized. In such cases, each BS shall transmit the same PDUs, using the same transmission mechanism (symbol, subchannel, modulation, etc.) at the same time. In order to indicate the allocation of MBS data, MBS MAP shall denote the corresponding bursts with multicast CIDs assodiated with certain service flows within a given MBS zone [5].

2.2 Simulation Environment

A single-frequency network (SFN) operation can be realized for broadcast traffic transmitted using OFDMA from neighboring cells with timing errors within the cyclic prefix length. A 1-tier MBS zone with SFN is illustrated in Fig. 1. This figure also shows the locations of MSs in the cell for our computer simulations, with a cell radius of 1km, and the axis of the BSs in the neighboring cells. These cases are classified by the distance from BS0 to the location of MSs in the center cell. we considerd 3-cases of MS's location according to the distance from the center of the serving cell.

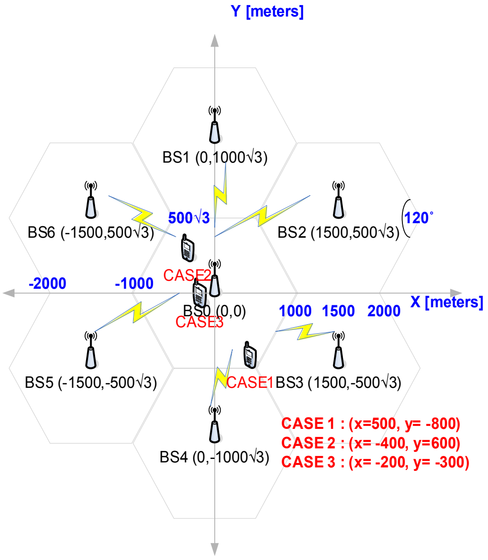

Fig. 1. The 1-tier SFN environment for our computer simulation.

- CASE1 : MS is located in near the edge of a cell.
- CASE2 : MS is located in the middle of center and edge in a cell.
- CASE3 : MS is located in near the center of a cell.

The main parameters for our computer simulation are illustrated in Table 1. These parameters are related to the standard IEEE 802.16e (Mobile WiMAX). In particular, only the partial usage of subchannels (PUSC) allocation scheme is used in the MBS zone for our computer simulation.

The block diagram in Fig. 3, used for the

Table 1. Simulation Parameters for SFN

Parameters	Value
Frame Length	5 [msec]
Sampling Frequency	10 [MHz]
Subchannel Allocation	PUSC
Channel Estimation	Least Square & Interpolation
Number of Tiers for SFN	1

computer simulation to determine the bit-error rate (BER) performance. In this paper, we consider an OFDM system in a high delay spread environment as is the case for Single Frequency Networks (SFN). The multi-path delay spread is so small in comparison with the delay of signals from neighboring cells. So, we ignored the multi-path delay of NLOS environment in this paper, and we considered the only LOS environment because we want to analyze the effect of the only signals from other cells in the SFN environment.

The channel estimation method in a PUSC subchannel is a least squares (LS) scheme with linear interpolation as illustrated in Fig. 2. In Fig. 2, the pilot data are D0, E4, E8, and D12 in the cluster of a PUSC subchannel. To obtain the transfer functions of each subcarrier (H0 to H13), we assume that the transfer functions of both even and odd symbols are equal, that is to say, the wireless channel between even and odd symbols in the time domain is not changed. Figure 2 also shows the process to find the transfer functions from H0 to H13. In the first step, we calculate the transfer functions of the pilot location using the LS channel estimation method. In the second step, we also determine the other transfer functions of data location using the linear interpolation method.

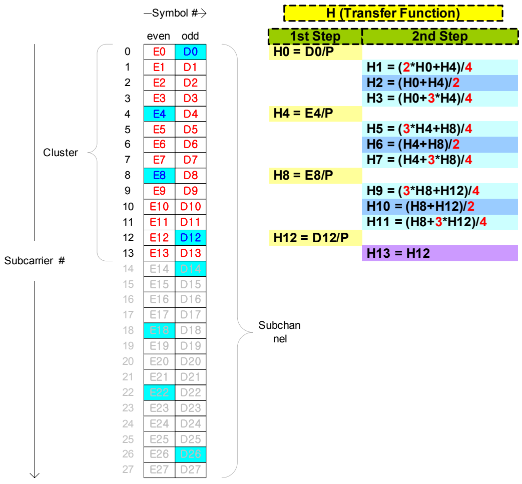

Fig. 2. LS channel estimation and linear interpolation in a PUSC subchannel.

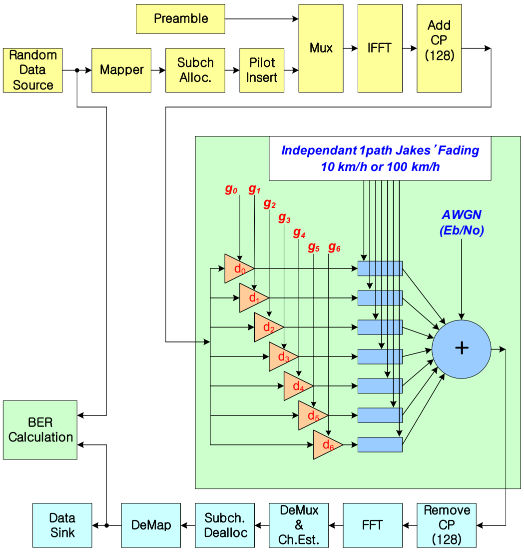

Fig. 3. Baseband simulation block diagram for 1-tier SFN in Fig. 1.

The d_n (d0~d6) in Fig. 3 represents the normalized delays of the signal transmitted from BS_n in the neighboring cells, shown in (1).

$$
\begin{aligned}
d_n &= \frac{\overline{(BS_n - MS)} - \overline{(BS_0 - MS)}}{c} \\
&= \frac{\sqrt{(x_{BS_n} - x_{MS})^2 + (y_{BS_n} - y_{MS})^2} - \sqrt{(x_{BS_0} - x_{MS})^2 + (y_{BS_0} - y_{MS})^2}}{c}
\end{aligned}
\tag{1}
$$

where $C(3 \times 10^8 m/\sec)$ is the velocity of light, and x_{MS} , y_{MS} are the axis of MSs and x_{BS_n} , y_{BS_n} are the axis of BS_n in Fig. 3.

The g_n (g0~g6) in Fig. 3 represents the normalized path loss gain of the signal transmitted from BSs in the neighboring cells, shown in (4). To obtain (4), RD_n and RPL_n are used in (2) and (3). The RD_nin (2) is the relative normalized distance from the BSs in the neighboring cells to the MS, and RPL_n in (3) is the relative path loss of signals transmitted from neighboring cells. However, the received power transmitted from a BS is inversely proportional to d^4 (-40dB/decade), where d is the distance from the MS to the BSs.

$$RD_n = \frac{\overline{(BS_n - MS)}}{\overline{(BS_0 - MS)}} = \frac{\left(\sqrt{(x_{BS_n} - x_{MS})^2 + (y_{BS_n} - y_{MS})^2}\right)}{\sqrt{(x_{BS_0} - x_{MS})^2 + (y_{BS_0} - y_{MS})^2}} \quad (2)$$

$$RPL_n = -10\log\left(RD_n^4\right)\ [dB] \quad (3)$$

$$g_n = 10^{\frac{RPL_n}{10}} \quad (4)$$

Therefore, the last values of d_n and g_n in such cases are shown in Table 2 through 4.

Table 2. Gain and delay values in CASE1 (x=500, y=-800)

CASE1	g_n	d_n [samples]
BS0	g0 = 1	d0 = 0
BS3	g3 = 0.78523881	d3 = 2
BS4	g4 = 0.316611596	d4 = 4
BS2	g2 = 0.055564666	d2 = 34
BS5	g5 = 0.049398519	d5 = 36
BS1	g1 = 0.017851079	d1 = 55
BS6	g6 = 0.017253582	d6 = 56

Table 3. Gain and delay values in CASE2 (x=-400, y=600)

CASE2	g_n	d_n [samples]
BS0	g0 = 1	d0 = 0
BS6	g6 = 0.164840804	d6 = 14
BS1	g1 = 0.130122943	d1 = 16
BS5	g5 = 0.023962222	d5 = 37
BS2	g2 = 0.019958571	d2 = 40
BS4	g4 = 0.00862719	d4 = 55
BS3	g3 = 0.008152255	d3 = 56

Table 4. Gain and delay values in CASE3 (x=-200, y=-300)

CASE3	g_n	d_n [samples]
BS0	g0 = 1	d0 = 0
BS5	g5 = 0.004181464	d5 = 35
BS4	g4 = 0.003866112	d4 = 36
BS6	g6 = 0.001817174	d6 = 46
BS3	g3 = 0.001639731	d3 = 48
BS1	g1 = 0.000972243	d1 = 56
BS2	g2 = 0.00093581	d2 = 57

Ⅲ. Simulation Results

Figure 3 shows a baseband simulation block diagram on the basis of the IEEE 802.16e standard for a 1-tier SFN environment. The BER performance results in the cases from the computer simulation in this letter are shown in Figs. 4 through 6. In these figures, if the path number (path #) is one, the receiver combines only the main path signal from BS0. When the path number is two, it combines the signals from BS0 and the signal having the next smallest delay (d_n) from BS_n. In this way, it combines the signals in the order of small to large delay (d_n), as illustrated in Table 2 through 4.

Figures 4 shows the uncoded BER performance in CASE 1, which are the cases in which the location of the MS is near the cell boundary. This case can obtain macro-diversity gain in the MBS zone, and only the nearest path transmitted from a neighboring cell is the most helpful to

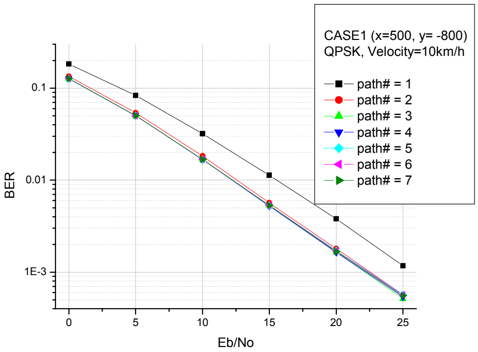

Fig. 4. Uncoded BER performance in CASE1.

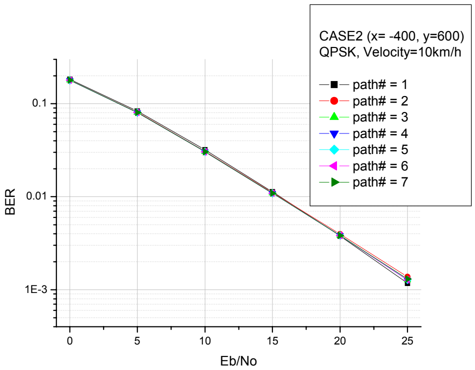

Fig. 5. Uncoded BER performance in CASE 2.

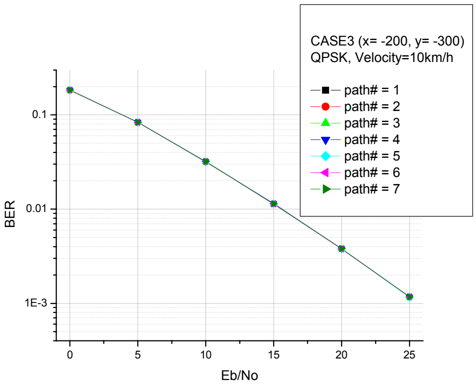

Fig. 6. Uncoded BER performance in CASE 3.

macro-diversity gain, but the other signals are not, as illustrated in these figures.

Figures 5 and 6 show the uncoded BER performance in CASE 2 and CASE 3, which are the cases in which the location of the MS is near the center of the cell. These cases cannot obtain macro-diversity gain in the MBS zone regardless of the path number. That is to say, it is useless to use multiple signals from neighboring cells.

Ⅳ. Conclusions

On the basis of the simulation results, we summarize that only MSs in the cell boundary can obtain macro-diversity gain in an MBS zone, and only the nearest path transmitted from a neighboring cell is the most helpful to the gain of macro-diversity, while the other signals are either a little useful or not helpful at all. In this paper, what we are trying to say is that macro-diversity gain can be obtained from the signal of the nearest neighboring cell when MS is located in cell edge.

Therefore, we concluded that an MBS zone should be configured within 1-tier in order to obtain the macro-diversity gain, and that the location of the MS in a cell should be considered when configuring an MBS zone in an IEEE 802.16e (Mobile-WiMAX) environment.

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