Selective MIMO Diversity with Subcarrier-wise UE Antenna Identification/Selection

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Abstract— **Spatial diversity is a powerful means to improve the bit error rate (BER) performance in a frequency-selective fading channel. Generally, only a few antennas are available at the user equipment (UE) due to the hardware complexity and cost issue, while a large number of antennas can be equipped at the base station (BS). In this paper, we study a simple selective multi-input multi-output (MIMO) diversity with subcarrier-wise UE antenna identification/selection. Maximal-ratio transmit frequency-domain equalization (MRT-FDE) and minimum mean square error combining FDE (MMSEC-FDE) are respectively used for the orthogonal frequency-division multiplexing (OFDM) downlink and the single-carrier (SC) uplink. It is confirmed by computer simulation that, without introducing space-time block coded transmit diversity (STBC-TD), additional diversity gain can be obtained by selective MIMO diversity.**

Keywords—MIMO diversity; channel estimation; antenna selection

I. INTRODUCTION

Spatial diversity is a powerful means to improve the bit error rate (BER) performance in a fading channel [1,2]. Generally, only a few antennas are available at a user equipment (UE) while a large number of antennas can be equipped at a base station (BS). The space-time block coded transmit diversity (STBC-TD) [3] is a well-known multi-input multi-output (MIMO) diversity which utilizes multiple BS and UE antennas to achieve a large diversity gain. In a frequency-selective fading channel, a joint use of equalization and diversity is necessary. In our previous study [4], we considered STBC-TD jointly used with maximal-ratio transmission frequency-domain equalization (MRT-FDE) for the orthogonal frequency-division multiplexing (OFDM) downlink [5] and that jointly used with minimum mean square error combining FDE (MMSEC-FDE) for the single-carrier (SC) uplink [6]. All signal processing necessary for MRT-FDE and MMSEC-FDE can be implemented solely at the BS [5,6] and hence, keeping the signal processing at UE simple.

An interesting question is whether STBC-TD is needed in order to utilize multiple BS and UE antennas. It should be noticed that if STBC-TD is not introduced, MIMO diversity using MRT/MMSEC-FDE permits only single receive/transmit UE antenna although multiple BS antennas can be utilized and hence, the achievable diversity gain is limited. In this paper, motivated by the above discussion, we study a simple selective MIMO diversity with subcarrier-wise UE antenna identification/selection, which can utilize multiple UE antennas without introducing STBC-TD while using MRT/MMSEC-FDE at the BS side. In selective MIMO diversity, the best antenna among multiple UE antennas is identified for each subcarrier. Pilot-aided channel estimation (PACE) is employed for obtaining MIMO channel state information (CSI), then the MIMO CSI is used for identifying/selecting the best UE antenna and for computing MRT/MMSEC-FDE weights at BS prior to data transmission. In this paper, it is assumed that SC waveform is generated by discrete Fourier transform (DFT)-spread OFDM principle. Selective MIMO diversity has a simpler transceiver structure than STBC-TD jointly used with MRT/MMSEC-FDE.

This paper is organized as follows. Section II describes the concept of selective MIMO diversity and then, Section III describes the identification/selection of the best UE antenna and the computation of MRT/MMSEC-FDE weights. Selective MIMO diversity transmission/reception is described in Sect. IV. In Sect. V, the BER performance in a frequency-selective Rayleigh fading channel is evaluated by computer simulation. Finally, Sect. VI offers concluding remarks.

II. SELECTIVE MIMO DIVERSITY CONCEPT

An equal number N_c of subcarriers is assumed for OFDM downlink and SC uplink. BS and UE are assumed to have N_{BS} antennas and N_{UE} ($<N_{BS}$) antennas, respectively. The time-division duplex (TDD) is assumed, which can exploit the channel reciprocity in antenna selection.

The concept of selective MIMO diversity is illustrated in Fig. 1. The transmitter/receiver structure of selective MIMO diversity is illustrated in Fig. 2. All of N_{BS} BS antennas are used while the best one among N_{UE} UE antennas is chosen. The best UE antenna is identified for each subcarrier by BS (and selected by UE afterward) to perform $N_{BS}\times 1$ MRT-FDE for OFDM downlink and $1\times N_{BS}$ MMSEC-FDE for SC uplink.

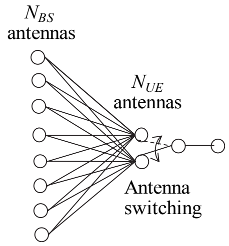
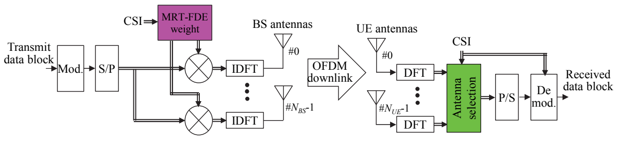
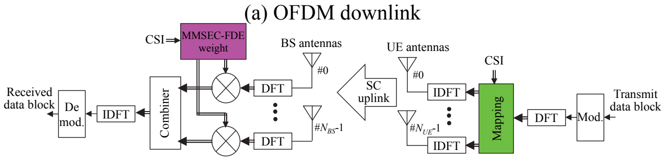


Fig. 1. Selective MIMO diversity concept. (N_{BS}, N_{UE})=(8, 2).



(a) OFDM downlink



(b) SC uplink

Fig. 2. Transmitter/receiver structure of selective MIMO diversity.

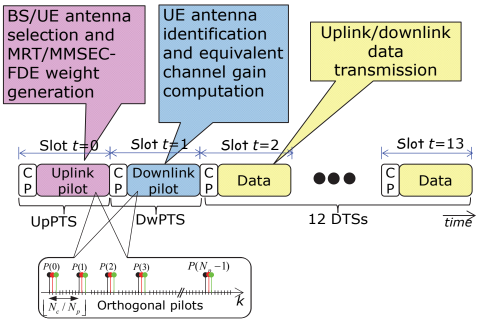


Fig. 3. Subframe structure.

III. IDENTIFICATION/SELECTION OF BEST UE ANTENNA AND COMPUTATION OF MRT/MMSEC-FDE WEIGHTS

The transmission subframe considered in this paper consists of uplink pilot time slot (UpPTS), downlink PTS (DwPTS), followed by 12 data time slots (DTSs) as illustrated in Fig.3 [7]. During UpPTS period (slot time t=0), UE transmits the orthogonal uplink pilots from N_{UE} antennas. After performing PACE using the received uplink pilot, BS uses the MIMO CSI to identify the best UE antenna for computing MRT/MMSEC-FDE weights. Then, during DwPTS period (slot time t=1), BS transmits orthogonal downlink pilots from N_{BS} antennas. After performing PACE using the received downlink pilot, UE uses the MIMO CSI to select the UE antenna identified by BS. During slot time t=2~13, BS continues to use the MRT-FDE weight $W_m^{MRT}(k)$ for OFDM downlink transmission and the MMSEC-FDE weight $W_m^{MMSECD}(k)$ for SC uplink reception.

Throughout the paper, discrete-time representation normalized by inverse discrete Fourier transform (IDFT) sampling period T_s is used, where $T_s = T/N_c$ with T being the IDFT block length in time.

A. Orthogonal pilot construction

Uplink and downlink pilots are a type of frequency-division multiplexed (FDM) pilot with equally spaced pilot subcarrier mapping. Pilots $\{p_g(\nu); \nu = 0 \sim N_c-1, g = 0 \sim \lfloor N_c/N_p \rfloor - 1\}$, with ν denoting the time instant in the Up/DwPTS period, can be constructed based on the Zadoff-Chu sequence [8] of N_p-symbol length, $\{P(\omega); \omega = 0 \sim N_p-1\}$ with $|P(\omega)| = 1$. By filling all subcarriers except $\{k = g + \omega \cdot \lfloor N_c/N_p \rfloor; \omega = 0 \sim N_p - 1\}$ with zeros and applying N_c-point IDFT, $p_g(\nu)$ is constructed as [9]

$$\begin{cases} p_g(\nu) = \dfrac{1}{\sqrt{N_c}} \displaystyle\sum_{k=0}^{N_c-1} \sqrt{2S} P_g(k) \exp\left(j2\pi \frac{k}{N_c} \nu \right) \\ P_g(k) = \begin{cases} P(\omega) & \text{if } k = g + \omega \cdot \lfloor N_c/N_p \rfloor \text{ for } \omega = 0 \sim N_p - 1 \\ 0 & \text{otherwise} \end{cases} \end{cases}, \quad (1)$$

where $\lfloor a \rfloor$ denotes an integer greater than or equal to a. The pilot sequence length N_p should satisfy the condition $\tau_{\max} < N_p \le \lfloor N_c / \max\{N_{BS}, N_{UE}\} \rfloor$, where $\tau_{\max}$ represents the maximum time delay of multipath fading channels. $\lfloor N_c/N_p \rfloor$ pilots constructed by Eq. (1) are orthogonal to each other. Different pilots are chosen for transmitting simultaneously from UE antennas or BS antennas. It should be noted that all pilots have the same power of $(S/N_c) \cdot N_p < S$, where S represents the average power of data signals to be transmitted at slot time t=2~13.

B. UE antenna identification and MRT/MMSEC-FDE weights computation at slot time t=0

UE transmits the orthogonal pilots $\{p_{g=n}(\nu); n = 0 \sim N_{UE}-1\}$ simultaneously from N_{UE} antennas during the UpPTS period (slot time t=0). Without loss of generality, N_{UE} pilots are chosen in the ascending order of index g in Eq. (1). BS transforms the pilot received on the $m(=0 \sim N_{BS}-1)$ th antenna into the frequency-domain received pilot by performing N_c-point DFT and then, picks up frequency components at $\{k = n + \omega \cdot \lfloor N_c/N_p \rfloor; \omega = 0 \sim N_p - 1\}$ for each of N_{UE} antennas. Since we are assuming that the maximum time delay of the multipath channels is $\tau_{\max} < \lfloor N_c / \max\{N_{BS}, N_{UE}\} \rfloor$, the delay-time domain windowing technique [10,11] can be used to obtain the channel gain estimates $\{\hat{H}_{m,n}(k, t=0); k = 0 \sim N_c - 1\}$ between the mth BS antenna and the nth UE antenna.

Using the channel gain estimates, BS identifies the best UE antenna $\breve{n}(k)$ as

$$\breve{n}(k) = \underset{n=0\sim N_{UE}-1}{\arg\max} \sum_{m=0}^{N_{BS}-1} \left| \hat{H}_{m,n}(k, t=0) \right|^2. \quad (2)$$

Hereafter, unless otherwise stated, the index k will be omitted from $\breve{n}(k)$ for the sake of brevity. Assuming that the UE can correctly select the $\breve{n}(k)$ th antenna, BS computes the MRT-FDE weight $W_m^{MRT}(k)$ for OFDM downlink transmission and the MMSEC-FDE weight $W_m^{MMSECD}(k)$ for SC uplink reception. They are given as

$$W_m^{MRT}(k)=\left(\frac{\hat{H}^*_{m,\breve{n}}(k,t=0)}{\sum_{m=0}^{N_{BS}-1}\left|\hat{H}_{m,\breve{n}}(k,t=0)\right|^2}\right)\Bigg/\sqrt{\frac{1}{N_c}\sum_{k=0}^{N_c-1}\left(\sum_{m=0}^{N_{BS}-1}\left|\hat{H}_{m,\breve{n}}(k,t=0)\right|^2\right)^{-1}}$$

for OFDM downlink transmission (3)

$$W_m^{MMSEC}(k)=\frac{\hat{H}^*_{m,\breve{n}}(k,t=0)}{\sum_{m=0}^{N_{BS}-1}\left|\hat{H}_{m,\breve{n}}(k,t=0)\right|^2+(E_s/N_0)^{-1}}$$

for SC uplink reception, (4)

where E_s represents the average transmit data symbol energy given by $E_s=S\cdot T_s$ and N_0 denotes the single-sided power spectrum density of zero-mean complexed-valued additive white Gaussian noise (AWGN).

The MRT-FDE weight of Eq. (3) is a combination of the conventional MRT-FDE weight [5] and 2-dimensional (antennas and subcarriers) power allocation for keeping the transmit power intact (i.e., always equal to S). It maximizes the received signal-to-noise power ratio (SNR) at the UE receiver. On the other hand, the MMSEC-FDE weight of Eq. (4) sufficiently weakens the frequency-selectivity of the equivalent channel seen at the BS receiver (the equivalent channel will be discussed in Sect. IV).

C. UE antenna selection and equivalent OFDM downlink channel gain computation at slot time t=1

MBS transmits the orthogonal pilots $\{p_{g=m}(\nu); m=0\sim N_{BS}-1\}$ simultaneously from N_{BS} antennas during the DwPTS period (slot time t=1). Similar to the uplink PACE using the delay-time domain windowing technique [10,11] performed at BS, UE obtains the channel gain estimates $\left\{\hat{H}_{m,n}(k,t=1); k=0\sim N_c-1\right\}$. Then, UE selects the $\breve{n}(k)$th antenna, which has been identified by BS as the best among N_{UE} antennas. This is done using Eq. (2) with replacing $\hat{H}_{m,n}(k;t=0)$ by $\hat{H}_{m,n}(k;t=1)$.

We have derived an approximate expression for the probability P_f of false identification and selection of the best UE antenna in a frequency-selective Rayleigh fading channel. In the case of N_{UE}=2, P_f is expressed as (for the sake of brevity, its derivation process is omitted)

$$P_f\approx 2\int_0^\infty\int_0^{\alpha_0}\frac{(\alpha_0\alpha_1)^{N_{BS}-1}}{\{(N_{BS}-1)!\}^2}\exp\left(-(\alpha_0+\alpha_1)\right)\times erfc\left(\frac{\sqrt{E_s/N_0}}{2\sqrt{2}}\frac{\alpha_0-\alpha_1}{\alpha_0+\alpha_1}\right)d\alpha_0 d\alpha_1, \tag{5}$$

where $erfc(x)=(2/\sqrt{\pi})\int_x^\infty\exp\left(-t^2\right)dt$ is the complementary error function and $\alpha_n=\sum_{m=0}^{N_{BS}-1}\left|H_{m,n}(k)\right|^2$. It can be found that if average transmit E_s/N_0 is higher than 0 dB, the false probability is lower than 0.04 and can be sufficiently small. In the computer simulation shown in Sect. V, the identification and selection of the best UE antenna are respectively carried out by PACE using uplink and downlink pilots for the BER performance evaluation. It should be noted that the negative impact of the false identification and selection on the BER performance is included in the simulation.

In addition, it should be noted that the downlink pilot can be an MRT-FDE-precoded pilot using N_c subcarriers. In this case, the UE antenna selection can be done by comparing the instantaneous pilot received powers on N_{UE} antennas for each subcarrier.

IV. SIGNAL TRANSMISSION/RECEPTION WITH SELECTIVE MIMO DIVERSITY

The OFDM downlink and SC uplink transmission systems with selective MIMO diversity have been illustrated in Fig. 2. Below, the received signal representation is presented. The equivalent channel gain for symbol decision is obtained.

A. OFDM downlink

BS transforms an N_c-symbol data block $\{d(\nu,t); \nu=0\sim N_c-1\}$ with $E[|d(\nu,t)|^2]=1$ to be transmitted during slot time t into the frequency-domain signal $\{d(k,t); k=0\sim N_c-1\}$ by serial-to-parallel (S/P) conversion and then, multiplies $d(k,t)$ by $W_m^{MRT}(k)$. The resultant frequency-domain signal $\left\{\sqrt{2S}W_m^{MRT}(k)d(k,t); k=0\sim N_c-1\right\}$ to be transmitted from the mth BS antenna is transformed back to the time-domain OFDM signal by N_c-point IDFT. After inserting the cyclic-prefix (CP), the resultant time-domain signals are transmitted from N_{BS} antennas.

UE transforms the OFDM signals received on N_{UE} antennas by N_c-point DFT into the frequency-domain signals. Then, for each $k(=0\sim N_c-1)$, UE selects the frequency component $R_{\breve{n}}(k,t)$ received on the $\breve{n}(k)$th antenna. The antenna selection output $\{R(k,t); n=0\sim N_c-1\}$ can be written as

$$R(k,t)=\sqrt{2S}H_e(k,t)d(k,t)+\Pi_{\breve{n}}(k,t), \tag{6}$$

where $H_e(k,t)$ and $\Pi_{\breve{n}}(k,t)$ are the equivalent channel gain and the noise due to AWGN, respectively. $H_e(k,t)$ is given as

$$H_e(k,t) = \sum_{m=0}^{N_{BS}-1}W_m^{MRT}(k)H_{m,\breve{n}}(k,t)\cdot \tag{7}$$

Therefore, the symbol decision rule is expressed as

$$\hat{d}(k,t)=\arg\min_{d\in\mathbf{D}}\left|R(k,t)-\sqrt{2S}\hat{H}_e(k,t)d\right|,\quad k=0\sim N_c-1, \tag{8}$$

where d and **D** denote the symbol candidate and a set of candidate symbols, respectively. After parallel-to-serial (P/S) conversion, UE outputs the received N_c-symbol data block $\left\{\hat{d}(\nu,t); \nu=0\sim N_c-1\right\}$. Since $H_e(k,t)$ is unknown to UE, it is replaced with its estimate $\hat{H}_e(k,t)$, which is computed as

$$\hat{H}_e(k,t)=\sum_{m=0}^{N_{BS}-1}W_m^{MRT}(k)\hat{H}_{m,\breve{n}}(k,t=1)$$
$$=1\Bigg/\sqrt{\frac{1}{N_c}\sum_{k=0}^{N_c-1}\left(\sum_{m=0}^{N_{BS}-1}\left|\hat{H}_{m,\breve{n}}(k,t=1)\right|^2\right)^{-1}} \quad (9)$$

by replacing $\hat{H}_{m,\breve{n}}(k,t=0)$ in $W_m^{MRT}(k)$ with $\hat{H}_{m,\breve{n}}(k,t=1)$ since it is unknown to UE. Note that if the MRT-FDE-precoded downlink pilot is used at slot time t=1, estimation of $H_e(k,t)$ and UE antenna selection can be simultaneously carried out..

B. SC uplink

UE transforms an N_c-symbol data block $\{d(\nu,t);\nu=0\sim N_c-1\}$ into the frequency-domain signal $\{D(k,t);k=0\sim N_c-1\}$ by N_c-point DFT. Then, $\{D(k,t);k=0\sim N_c-1\}$ are mapped to N_{UE} antennas according to the antenna selection $\{\breve{n};k=0\sim N_c-1\}$. The resultant frequency-domain signal $\left\{\sqrt{2S}D_n(k,t);k=0\sim N_c-1\right\}$ to be transmitted during slot time t from the nth UE antenna is transformed back to the time-domain SC signals by N_c-point IDFT, where $D_n(k,t)=D(k,t)$ if $n=\breve{n}(k)$ and $D_n(k,t)=0$ otherwise. The resultant time-domain signals are transmitted from N_{UE} antennas.

After transforming the signal received on its mth antenna by an N_c-point DFT into the frequency-domain signal $\{R_m(k,t);k=0\sim N_c-1\}$, BS performs MMSEC-FDE as

$$R(k,t)=\sum_{m=0}^{N_{BS}-1}W_m^{MMSEC}(k)R_m(k,t)\cdot \quad (10)$$

For carrying out the symbol decision, the time-domain received signal $\{r(\nu,t);\nu=0\sim N_c-1\}$ is obtained by applying N_c-point IDFT to $\{R(k,t);k=0\sim N_c-1\}$. $R(k,t)$ can be written as

$$R(k,t)=\sqrt{2S}H_e(k,t)D(k,t)+\sum_{m=0}^{N_{BS}-1}W_m^{MMSEC}(k)\Pi_m(k,t), \quad (11)$$

where $H_e(k,t)$ is the equivalent channel gain given by $\sum_{m=0}^{N_{BS}-1}W_m^{MMSEC}(k)H_{m,\breve{n}}(k,t)$ and $\Pi_m(k,t)$ is the noise due to AWGN. Since $H_e(k;t)$ is unknown to BS, it is replaced with its estimate $\hat{H}_e(k,t)$. The symbol decision rule is expressed as

$$\hat{d}(\nu,t)=\arg\min_{d\in\mathbf{D}}\left|r(\nu,t)-\sqrt{2S}\left(\frac{1}{N_c}\sum_{k=0}^{N_c-1}\hat{H}_e(k,t)\right)d\right|, \quad (12)$$

where $\hat{H}_e(k,t)$ can be computed by using $W_m^{MMSEC}(k)$ of Eq. (4) and replacing $H_{m,\breve{n}}(k,t=0)$ with $\hat{H}_{m,\breve{n}}(k,t=0)$ as

$$\hat{H}_e(k,t)=\sum_{m=0}^{N_{BS}-1}W_m^{MMSEC}(k)H_{m,\breve{n}}(k,t=0)$$
$$=\frac{\sum_{m=0}^{N_{BS}-1}\left|\hat{H}_{m,\breve{n}}^{*}(k,t=0)\right|^2}{\sum_{m=0}^{N_{BS}-1}\left|\hat{H}_{m,\breve{n}}(k,t=0)\right|^2+\left(E_s/N_0\right)^{-1}}. \quad (13)$$

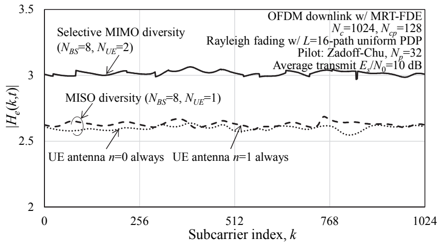
V. COMPUTER SIMULATION

The average uncoded BER performances of OFDM downlink and SC uplink with selective MIMO diversity are evaluated by computer simulation. The computer simulation parameters are summarized in Table I. It is assumed that BS and UE are equipped with N_{BS}=4~16 antennas and N_{UE}=2 antennas, respectively. $N_{BS}\times N_{UE}$ channels are assumed to be i.i.d. quasi-static frequency-selective Raleigh fading channels having L-path uniform power delay profile (PDP) with $\tau_{\max}=L-1$, where L=1~16 in this paper. The number of subcarriers (equal to IDFT/DFT size) is N_c=1024 and the cyclic prefix (CP) length is N_{cp}=128. Prior to data transmission, the best UE antenna is identified/selected by PACE using delay-time domain windowing technique. The Zadoff-Chu sequence [8] of N_p=32-symbol length is employed as the pilot symbol sequence $\{P(\omega);\omega=0\sim N_p-1\}$. N_p=32 satisfies the condition $\tau_{\max}<N_p\le\lfloor N_c/\max\{N_{BS},N_{UE}\}\rfloor$. The perfect knowledge of received E_s/N_0 is assumed for computing the MMSEC-FDE weights of Eq. (4) and the equivalent channel gain estimate of Eq. (13). 4QAM data modulation is assumed.

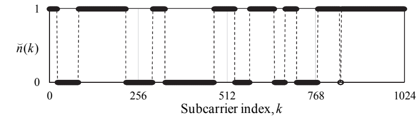
TABLE I. COMPUTER SIMULATION PARAMETERS

Subframe structure (14 slots)	No. of subcarriers	N_c=1024
	CP length	N_{cp}=128 samples
	Uplink/downlink pilots	Zadoff-Chu
	Data (12 slots)	4QAM
Fading channel	Type of fading	Quasi-static frequency-selective Rayleigh
	PDP	L-path uniform
	Maximum delay time	$\tau_{\max}=L$-1
Selective MIMO diversity	No of BS antennas	N_{BS}=4, 8, and 16
	No of UE antennas	N_{UE}=2

One-shot observation of the best UE antenna index and equivalent channel gain over N_c subcarriers is shown for OFDM downlink with selective MIMO diversity in Fig. 4. For comparison, the equivalent channel gain achievable with multi-input single-output (MISO diversity), i.e., the same UE antenna (n=0 or 1) is always used for all subcarriers, is also plotted in Fig. 4(a). The selective MIMO diversity achieves higher equivalent channel gain than MISO diversity. Also seen is that selective MIMO diversity achieves less variations in the equivalent channel gain.

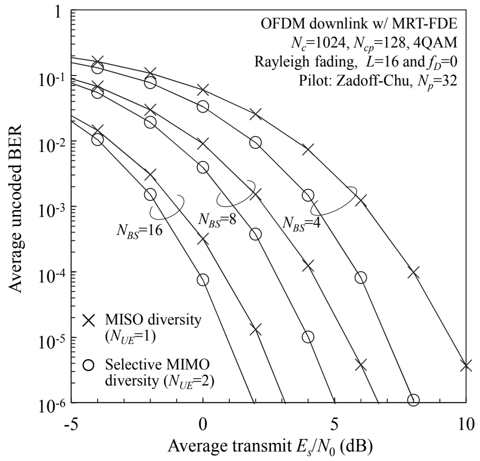


(a) Equivalent channel gain

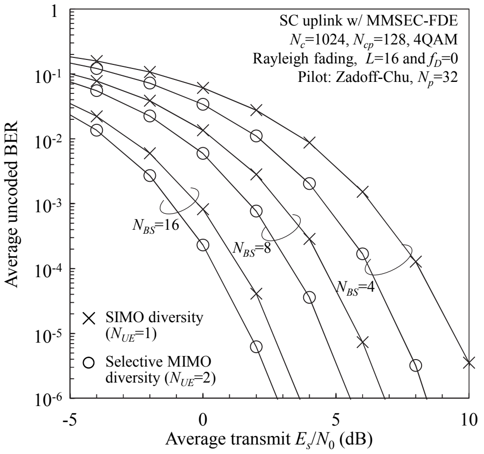


(b) Best UE antenna

Fig. 4. One-shot observation of best UE antenna and equivalent channel gain with selective MIMO diversity. OFDM downlink.



(a) OFDM downlink with MRT-FDE

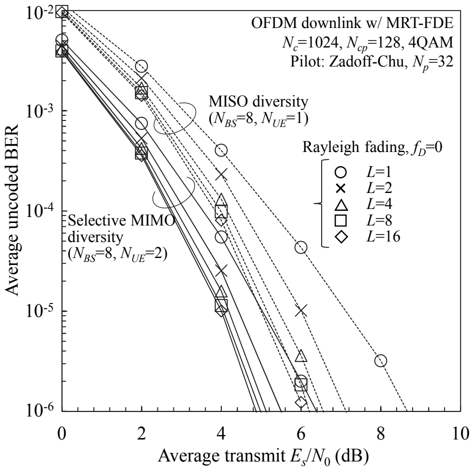


(b) SC uplink with MMSEC-FDE

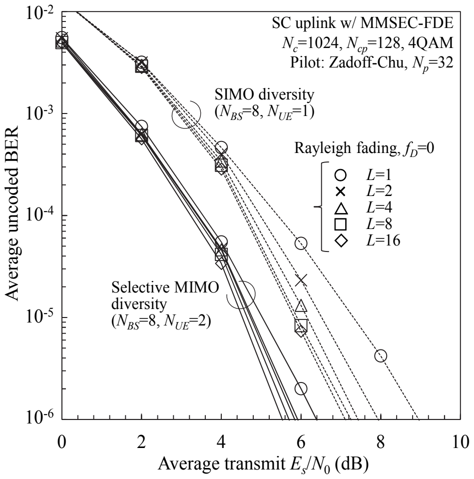
Fig. 5. Average uncoded BER perfornace.

The simulated average uncoded BER performance with selective MIMO diversity in a quasi-static frequency-selective Rayleigh fading channel (the maximum Doppler frequency f_D=0) is plotted in Fig. 5 for various values of N_{BS}. The transmit power loss due to CP insertion, which is 0.51dB was taken into account in the BER performance evaluation. For comparison, the average uncoded BER performance achievable with MISO/single-output multiple-output (SIMO) diversity is also plotted. It can be seen from the figure that selective MIMO diversity provides better performance than MISO/SIMO diversity. Furthermore, it is worthwhile to notice that the OFDM downlink and SC uplink provide similar BER performance.

The impact of the frequency-selectivity of the channel on the achievable BER performance is plotted in Fig. 6 for the case of N_{BS}=8. As the frequency-selectivity gets stronger (or as the number of resolvable paths increases from L=1 to 16), the BER performance improves. It can be understood from the figure that selective MIMO diversity always provides lower BER than MISO/SIMO diversity.



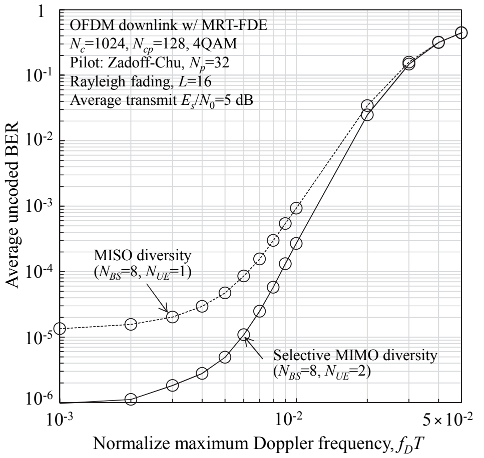
(a) OFDM downlink with MRT-FDE



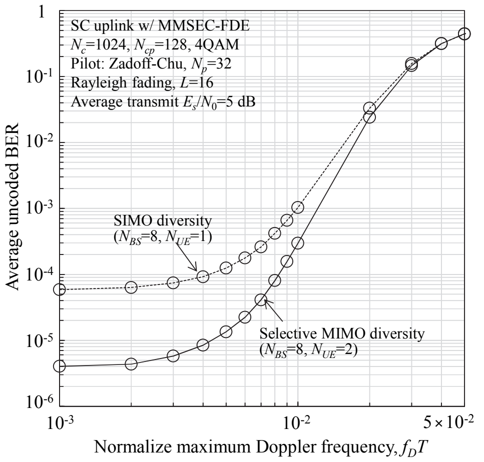
(b) SC uplink with MMSEC-FDE

Fig. 6. Impact of frequency-selectivity of the channel.

So far, the quasi-static fading has been assumed. If UE moves, the channels changes over the subframe period. However, the channel estimation for UE antenna selection and MRT/MMSEC-FDE weights computation are done by PACE using pilots transmitted at the beginning (t=0 and 1) of the subframe. Therefore, the achievable BER performance may degrade. Figure 7 plots the impact of the time-selectivity of the channel with L=16 on the achievable BER at the average transmit E_s/N_0=5dB as a function of the normalized maximum Doppler frequency f_DT, where T denotes the IDFT/DFT block length in time. Although the achievable BER increases as the time-selectivity gets stronger, selective MIMO diversity always provides lower BER than MISO/SIMO diversity. However, its superiority almost diminishes when f_DT becomes higher than about 0.02. Assuming the subcarrier spacing of 75 kHz and the carrier frequency of 5 GHz, T=13.33μs and hence, f_DT=0.02 corresponds to a UE moving speed of 324 km/h.



(a) OFDM downlink with MRT-FDE



(b) SC uplink with MMSEC-FDE

Fig. 7. Impact of time-selectivity of the channel.

VI. CONCLUSION

In this paper, selective MIMO diversity with subcarrier-wise UE antenna identification/selection was studied for OFDM downlink using MRT-FDE and SC uplink using MMSEC-FDE. Selective MIMO diversity has a simpler transceiver structure than STBC-TD jointly used with MRT/MMSEC-FDE [4]. The computer simulation confirmed that selective MIMO diversity improves the BER performance in a frequency-selective Rayleigh fading channel compared to MISO/SIMO diversity although STBC-TD is not jointly used.

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