On the Performance of the Block-Based Selective OFDM Decode-and-Forward Relaying Scheme for 4G Mobile Communication Systems

Wendong Yang and Yueming Cai

Abstract: **In this paper, we propose a block-based selective orthogonal frequency division multiplexing (OFDM) decode-and-forward relaying scheme for 4G mobile communication systems. In the scheme, an OFDM symbol is divided into blocks and one relay is selected for each block. Theoretical outage performance and error performance are analyzed and evaluated. A unified outage expression is given for our scheme and the other two schemes and the lower bound of the bit error rate of the three schemes is also obtained. The effect of the coherence bandwidth on the proposed scheme is also investigated. Monte Carlo simulations are carried out to validate our analysis. The scheme can obtain a good tradeoff between complexity and performance and can be used in future 4G mobile communication systems.**

Index Terms: **4th generation (4G), bit error rate (BER), cooperative communication, orthogonal frequency division multiplexing (OFDM), outage probability, relay selection.**

I. INTRODUCTION

With the rapid development of mobile communication technology, the research and development (R&D) of the 4th generation (4G) mobile communication has been initiated worldwide. It has become the general consensus that the 4G system should be an enhanced version of the 3rd generation (3G) system with its performance significantly better than that of the current 3G. Specifically, the 4G system should provide the users with a transmission rate up to 100 Mbps for high mobility usage, and with a transmission rate up to 1 Gbps for nomadic and local wireless usage. To realize this high rate, advanced technologies need to be developed. The advanced PHY layer technology, orthogonal frequency division multiplexing (OFDM), which eliminates the frequency selectivity effect by transmitting the wideband signal on multiple orthogonal subcarriers as narrow-band signals, has gained much attention [1]–[3]. Besides, multiple-input multiple-output (MIMO) technology, which can effectively combat channel fading, and increase the system capacity by using space-time signal processing, has been proposed [4]–[6]. However, due to size, cost, or hardware limitations, a mobile terminal may not be able to support multiple antennas. Cooperative communication, which allows single-antenna mobile terminals to share their antennas in a manner that creates a virtual MIMO system, can reap the benefits of MIMO systems and has been developed recently [7]–[10].

Now much importance has been attached to the research on OFDM based cooperative wireless networks. In [11], Li and Liu studied resource allocation for OFDMA relay networks with fairness constraints. In [12], Jeong and Lee proposed an adaptive relay selection for regenerative OFDMA relay networks with fairness constraints. In [13], Jeon *et al.* proposed a low complexity subcarrier pairing scheme for OFDM based multiple amplify-and-forward relay systems. In [14], Dai *et al.* studied selective relaying in OFDM multihop cooperative networks. In [15], Gui *et al.* studied selective relaying in two-hop cooperative OFDM systems. In [16], Dang *et al.* studied the joint allocation of power, subcarriers and relay nodes in multi-relay assisted two-hop cooperative OFDM systems with the objective of maximizing the system transmission rate. In [17], Zhang *et al.* tried to find an optimal power and time adaptation policy to minimize the outage probability in an OFDM based linear relay network. These researches can be classified into two types according to whether subcarrier pairing is involved. Since subcarrier pairing is too complex and hard to implement, we don't consider it in this paper. There are now two main relaying schemes which don't involve complex subcarrier pairing. One selects one relay for the entire OFDM symbol and the other selects one relay for each subcarrier. The two schemes are called selective OFDM relaying and selective OFDMA relaying, respectively in [14] and [15]. On the one hand, selective OFDM relaying is simple but it doesn't take good advantage of the frequency diversity, so its performance is rather poor. On the other hand, selective OFDMA relaying takes full advantage of the frequency diversity and has superior performance, but its complexity is rather high and it doesn't take into consideration the coherence bandwidth of the channel.

In this paper, in order to obtain a flexible tradeoff between performance and complexity, we propose a block-based selective OFDM decode-and-forward relaying scheme for 4G mobile communication systems, in which an OFDM symbol is divided into blocks and one relay is selected for each block. Theoretical outage performance and error performance are analyzed and evaluated. A unified outage expression is given for our scheme and the other two schemes and the lower bound of the bit error rate (BER) of the three schemes is also obtained. The effect of

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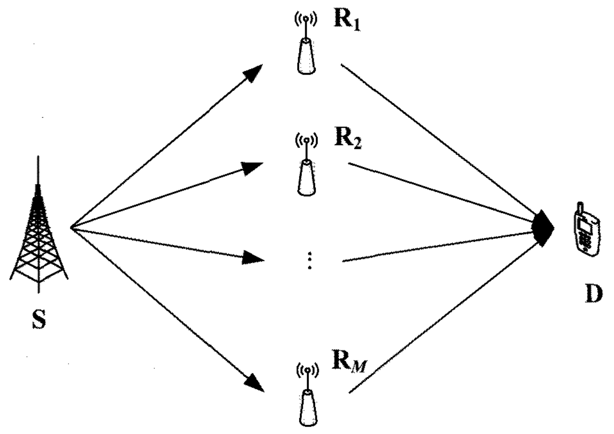

Fig. 1. System model.

the coherence bandwidth on the proposed scheme is also investigated. Monte Carlo simulations are carried out to validate our analysis.

II. SYSTEM MODEL

We consider a single source (S)-destination (D) cooperative system with M relays ($\mathrm{R}_1, \mathrm{R}_2, \cdots, \mathrm{R}_M$), as shown in Fig. 1. There is no direct link between the source and the destination because of distance or obstacles. The relays (either fixed or moving) are randomly located between the source and the destination. An OFDM transceiver with N subcarriers is available at each node. Perfect time and frequency synchronization among nodes are assumed. We also assume a cyclic prefix that is long enough to accommodate the channel delay spread.

We adopt a two-slot transmission protocol. In the first slot, the source transmits and the relays listen. The links in this slot are called the source-relay (SR) links. In the second slot, the relays retransmit the message to the destination. The links in this slot are called the relay-destination (RD) links. Here, we propose a block-based OFDM decode-and-forward relaying scheme for 4G mobile communication systems, in which an OFDM symbol is divided into B blocks and one relay is selected for each block.

We assume that the total required data rate is R_{total} bits per OFDM symbol. On average, each subcarrier will transmit $R{=}R_{\text{total}}/N$ bits. Further, denote the channel response of subcarrier n from the source to rely i and the channel response of subcarrier n from rely i to the destination as $h_{s,i}(n)$ and $h_{i,d}(n)$, respectively. In general, these channel responses capture the effects of path loss, shadowing, and Rayleigh fading. For convenience, denote the channel power gains $|h_{s,i}(n)|^2$ and $|h_{i,d}(n)|^2$ as $G_{s,i}(n)$ and $G_{i,d}(n)$, respectively.

For ease of presentation, the following assumptions are made.

- A1) Each relay operates in a half-duplex mode and employs a single antenna.
- A2) Each subcarrier has equal transmit power and the noise variances of each subcarrier are the same, i.e., the signal-to-noise ratio (SNR) on each subcarrier are the same.
- A3) Each block is comprised of $N_{\text{Block}} = N/B$ adjacent subcarriers, i.e., the block length is $N_{\text{Block}} = N/B$.
- A4) A log-distance path loss model is applied.
- A5) $h_{s,i}(n)$ and $h_{i,d}(n)$ are zero-mean mutually independent, circularly-symmetric complex Gaussian random variables.

III. OUTAGE ANALYSIS

In this section, we will evaluate the outage performance of the block-based OFDM decode-and-forward relaying scheme. Here, we don't consider bit loading and same number of bits are transmitted on each subcarrier. In this way, an outage occurs when at least one subcarrier cannot successfully support the transmission of R bits.

For the sake of comparison, we will also analyze the outage performance of selective OFDM relaying and selective OFDMA relaying, which can be granted as two extremes ($N_{\text{Block}} = N$ and $N_{\text{Block}} = 1$, respectively) of our scheme (hereafter, we will call it selective block relaying) and serve as the upper bound and lower bound of our scheme, respectively.

A. Selective OFDM Relaying (Upper Bound)

An approximate expression for the outage probability of selective OFDM relaying was given in [15], which is an approximation at high SNR. Generally, an exact expression for the outage probability of selective OFDM relaying can be given as

$$P_{\text{out}}^{\text{OFDM}} = \prod_{i=1}^{M} P_{\text{out},i}^{\text{OFDM}} = \prod_{i=1}^{M} \left(1 - \exp\left(-N\lambda_i \frac{2^{2R}-1}{\gamma_0}\right)\right) \tag{1}$$

where γ_0 is the SNR on each subcarrier without fading, and λ_i is the parameter of the exponential distribution $G_i(n)$ follows with $G_i(n)$ being the equivalent channel power gain through relay i on subcarrier n.

B. Selective OFDMA Relaying (Lower Bound)

An approximate expression for the outage probability of selective OFDMA relaying was given in [15], which is an approximation at high SNR. Generally, an exact expression for the outage probability of selective OFDMA relaying can be given as

$$P_{\text{out}}^{\text{OFDMA}} = 1 - \left(1 - \prod_{i=1}^{M}\left(1 - \exp\left(-\lambda_i \frac{2^{2R}-1}{\gamma_0}\right)\right)\right)^{N}. \tag{2}$$

C. Selective Block Relaying

In this scheme, relay selection is performed independently for each block. Outage will occur unless outage does not occur on each block. Therefore, the outage probability can be given as

$$P_{\text{out}}^{\text{Block}} = 1 - \prod_{b=1}^{B}\left(1 - P_{\text{out}}^{\text{Block}}(b)\right) \tag{3}$$

where $P_{\text{out}}^{\text{Block}}(b)$ is the outage probability of block b, and is given as

$$P_{\text{out}}^{\text{Block}}(b) = \prod_{i=1}^{M} P_{\text{out},i}^{\text{Block},b} \tag{4}$$

where $P_{\text{out},i}^{\text{Block},b}$ is the outage probability of block b through relay i, and is given as

$$\begin{aligned}
&P_{\text{out},i}^{\text{Block},b} \\
&= 1 - \prod_{n=1}^{N_{\text{Block}}} \left(1 - \Pr\left[\frac{1}{2}\log\left(1 + G_i\left(n\right)\gamma_0\right) < R\right]\right) \\
&= 1 - \prod_{n=1}^{N_{\text{Block}}} \left(1 - \Pr\left[G_i\left(n\right) < \frac{2^{2R}-1}{\gamma_0}\right]\right) \\
&= 1 - \prod_{n=1}^{N_{\text{Block}}} \left(\exp\left(-\lambda_i \frac{2^{2R}-1}{\gamma_0}\right)\right) \\
&= 1 - \left(\exp\left(-\lambda_i \frac{2^{2R}-1}{\gamma_0}\right)\right)^{N_{\text{Block}}} \\
&= 1 - \exp\left(-N_{\text{Block}}\lambda_i \frac{2^{2R}-1}{\gamma_0}\right).
\end{aligned} \tag{5}$$

Substitute (5) into (4) and we can get

$$\begin{aligned}
P_{\text{out}}^{\text{Block}}\left(b\right) &= \prod_{i=1}^{M} P_{\text{out},i}^{\text{Block},b} \\
&= \prod_{i=1}^{M} \left(1 - \exp\left(-N_{\text{Block}}\lambda_i \frac{2^{2R}-1}{\gamma_0}\right)\right).
\end{aligned} \tag{6}$$

Substitute (6) into (3) and we can get

$$\begin{aligned}
&P_{\text{out}}^{\text{Block}} = 1 - \prod_{b=1}^{B}\left(1 - P_{\text{out}}^{\text{Block}}\left(b\right)\right) \\
&= 1 - \prod_{b=1}^{B}\left(1 - \prod_{i=1}^{M}\left(1 - \exp\left(-N_{\text{Block}}\lambda_i \frac{2^{2R}-1}{\gamma_0}\right)\right)\right) \\
&= 1 - \left(1 - \prod_{i=1}^{M}\left(1 - \exp\left(-N_{\text{Block}}\lambda_i \frac{2^{2R}-1}{\gamma_0}\right)\right)\right)^{B}.
\end{aligned} \tag{7}$$

When $N_{\text{Block}} = 1$, selective block relaying is degenerated to selective OFDMA relaying, and by substituting $N_{\text{Block}} = 1$ into (7), we can get

$$P_{\text{out}}^{\text{Block}} = 1 - \left(1 - \prod_{i=1}^{M}\left(1 - \exp\left(-\lambda_i \frac{2^{2R}-1}{\gamma_0}\right)\right)\right)^{N} \tag{8}$$

which is absolutely equal to (2). When $N_{\text{Block}} = N$, selective block relaying is degenerated to selective OFDM relaying, and by substituting $N_{\text{Block}} = N$ into (7), we can get

$$P_{\text{out}}^{\text{Block}} = \prod_{i=1}^{M}\left(1 - \exp\left(-N\lambda_i \frac{2^{2R}-1}{\gamma_0}\right)\right) \tag{9}$$

which is absolutely equal to (1).

Now a unified outage expression has been developed for selective block relaying and the other two schemes, i.e., selective OFDM relaying and selective OFDMA relaying.

IV. ERROR ANALYSIS

In the last section, we have derived the outage performance of the three schemes. However, it is the error performance that is sometimes of more interest to us. Therefore, in this section, we will try to analyze the error performance, particularly the BER performance of the three schemes above. However, it is very hard to obtain closed-form expressions for the BER performance of selective OFDM relaying and selective block relaying. Fortunately, a closed-form expression for the BER performance of selective OFDMA relaying can be obtained, which can be granted as the lower bound of the BER of the three schemes.

As we have pointed out in the last section, $G_i\left(n\right)$, the equivalent channel power gain through relay i on subcarrier n, follows an exponential distribution with parameter λ_i, i.e., the probability density function (PDF) of $G_i\left(n\right)$ can be given as

$$p_{G_k(n)}\left(g\right) = \lambda_i e^{-\lambda_i g}. \tag{10}$$

Therefore, the PDF of the equivalent SNR through relay i on subcarrier n, $\gamma_i\left(n\right) = \gamma_0 G_i\left(n\right)$, can be given as

$$p_{\gamma_i(n)}\left(\gamma\right) = \frac{\lambda_i}{\gamma_0} e^{-\lambda_i \frac{\gamma}{\gamma_0}}. \tag{11}$$

And its cumulative distribution function (CDF) can be given as

$$F_{\gamma_i(n)}\left(\gamma\right) = 1 - e^{-\lambda_i \frac{\gamma}{\gamma_0}}. \tag{12}$$

For selective OFDMA relaying, relay selection is performed independently for each subcarrier and the relay with the largest equivalent SNR is selected for each subcarrier. Therefore, the equivalent SNR on subcarrier n after relay selection can be given as

$$\gamma\left(n\right) = \max_{i=1,\cdots,M} \gamma_i\left(n\right). \tag{13}$$

The CDF can be given as

$$F_{\gamma(n)}\left(\gamma\right) = \prod_{i=1}^{M} F_{\gamma_i(n)}\left(\gamma\right) = \prod_{i=1}^{M} 1 - e^{-\lambda_i \frac{\gamma}{\gamma_0}}. \tag{14}$$

By differentiating $F_{\gamma(n)}\left(\gamma\right)$ with respect to γ, the PDF of $\gamma\left(n\right)$ can be obtained as

$$\begin{aligned}
p_{\gamma(n)}\left(\gamma\right) &= \sum_{i=1}^{M} p_{\gamma_i(n)}\left(\gamma\right) \prod_{\substack{l=1 \\ l\neq i}}^{M} F_{\gamma_l(n)}\left(\gamma\right) \\
&= \sum_{i=1}^{M} \frac{1}{\Omega_i \gamma_0} e^{-\frac{1}{\Omega_i \gamma_0}\gamma} \prod_{j=1, j\neq i}^{M} \left(1 - e^{-\frac{1}{\Omega_j \gamma_0}\gamma}\right) \\
&= \sum_{i=1}^{M} \left(\frac{\left(-1\right)^i}{i!} \underbrace{\sum_{n_1=1}^{M} \cdots \sum_{n_i=1}^{M}}_{n_1 \neq n_1 \neq \cdots n_i} \Theta_i e^{-\Theta_i \gamma}\right)
\end{aligned} \tag{15}$$

where $\Theta_i = \sum_{l=1}^{i} \frac{1}{\gamma_0} \frac{1}{\Omega_{n_l}}$.

Therefore, the average BER of subcarrier n can be given as [18]

$$P_b(n) = \int_0^{\infty} Q\left(\sqrt{a\gamma}\right) p_{\gamma(n)}(\gamma) d\gamma \quad (16)$$

where $Q(x) = \frac{1}{\sqrt{2\pi}} \int_x^{\infty} e^{-t^2/2} dt$ is the Gaussian Q-function, and a is a modulation-dependent constant, e.g., $a = 2$ for binary phase shift keying (BPSK) and $a = 1$ for quaternary phase shift keying (QPSK).

Finally, the total average BER of the OFDM system is evaluated as

$$P_b = \frac{1}{N} \sum_{n=1}^{N} P_b(n). \quad (17)$$

Because each subcarrier experiences independent Rayleigh fading and relay selection is performed independently for each subcarrier, $P_b(n)$ is identical for each subcarrier, which can be found from the expression of $p_{\gamma(n)}(\gamma)$ given in (15). Therefore, (17) can be reduced to

$$P_b = P_b(n). \quad (18)$$

V. COMPLEXITY ANALYSIS AND IMPLEMENTATION CONSIDERATIONS

The complexity of the above three schemes mainly comes from the selection procedure and the signaling overhead. As for the selection procedure, the comparison operations the three schemes need are almost the same and there is no much difference among the three schemes. But for the signaling overhead, the difference among the three schemes are quite huge since the amount of the channel information and the feedback they require are very different. In future 4G mobile communication systems, there will definitely be base stations in the network and centralized implementation of the three schemes can thus be realized. The base station can collect all the channel information and then select relays based on the channel gains of the SR and RD links. For selective OFDM relaying, each relay only needs to feed back the value of $\min_{n=1,\cdots,N} G_i(n)$, and the base station selects the relay with the largest $\min_{n=1,\cdots,N} G_i(n)$ and signals it and the other relays. For selective OFDMA relaying, each relay needs to feed back the value of $G_i(n)$ of each subcarrier, and the base station has to select a relay for each subcarrier and signals all the relays. For selective block relaying, each relay needs to feed back the value of smallest equivalent channel power gain of each block, and the base station selects a relay for each block and signals the relays. The complexity of the proposed scheme will increase linearly with the number of blocks, while the performance of the scheme will improve with the number of blocks. Therefore, a tradeoff can be made between the complexity and the performance by choosing proper N_{Block}. If the performance is more important, we can divide OFDM symbols into more blocks and if more importance is attached to the complexity, we can divide OFDM symbols into fewer blocks. Besides, as will be shown in the next section, the block length should be determined according to the coherence bandwidth of the channel. Specifically, the larger the coherence bandwidth is, the larger the block length should be.

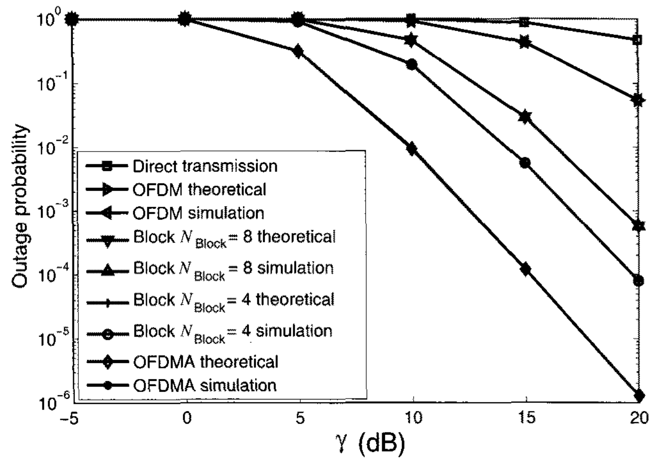

Fig. 2. Outage probability versus SNR with $M = 4$ and $N = 64$.

VI. SIMULATION RESULTS AND ANALYSIS

Monte Carlo simulations are carried out to validate our analysis. Simulations are carried out under the following settings. (1) $R = 1$ bit will be transmitted on each subcarrier, i.e., BPSK modulation is employed; (2) the path loss exponent is $\mu = 4$. We simulate the outage performance and the BER performance of the proposed selective block relaying and for the sake of comparison, the outage performance and the BER performance of selective OFDM relaying and selective OFDMA relaying is also simulated. Besides, the outage performance and the BER performance of direct transmission are also simulated as the baseline for comparison.

Fig. 2 illustrates the outage probability versus SNR with $M = 4$ and $N = 64$. It is obvious that significant performance gain can be obtained through cooperative communication. Besides, a perfect match can be observed between the theoretical and simulation results. As expected, the outage performance of selective block relaying is located between that of selective OFDM relaying and selective OFDMA relaying. We can also find that the outage performance improves with the number of blocks.

Fig. 3 illustrates the outage probability versus the number of relays with $\gamma = 10$ and $N = 64$. We can see that the outage performance of all the three selective relaying schemes improves exponentially with the increase of the number of relays. Besides, a perfect match can be observed between the theoretical and simulation results. As expected, the outage performance of selective block relaying is located between that of selective OFDM relaying and selective OFDMA relaying. We can again observe that the outage performance improves with the number of blocks.

Fig. 4 illustrates the outage probability versus the number of subcarriers with $\gamma = 10$ and $M = 4$. We can see that the outage performance of all the three selective relaying schemes degrades with the increase of the number of subcarriers. Besides, a perfect match can be observed between the theoretical and simulation results. As expected, the outage performance of selective block relaying is located between that of selective OFDM relaying and selective OFDMA relaying. We can also observe that the outage

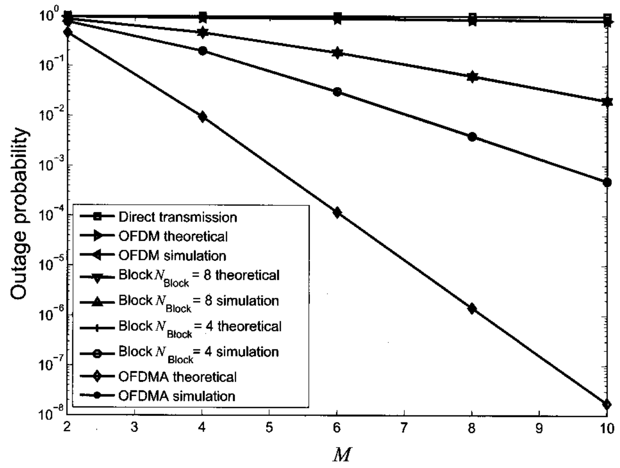

Fig. 3. Outage probability versus the number of relays with $\gamma = 10$ and $N = 64$.

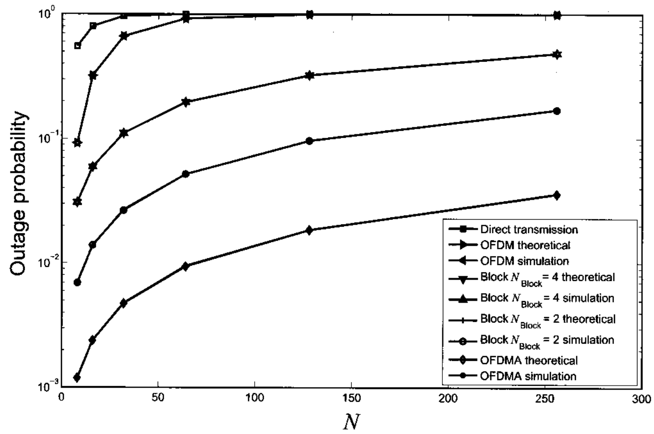

Fig. 4. Outage probability versus the number of subcarriers with $\gamma = 10$ and $M = 4$.

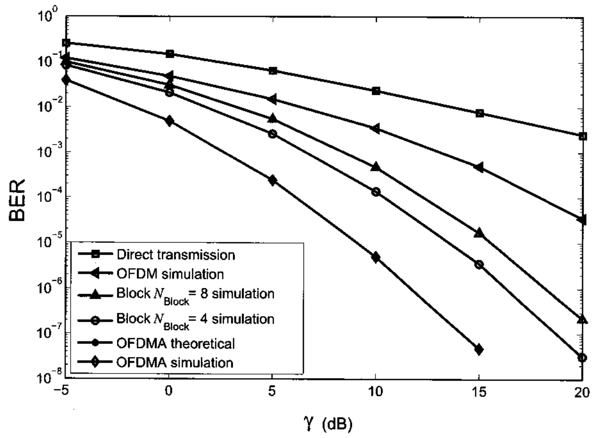

Fig. 5. BER versus SNR with $M = 4$ and $N = 64$.

performance improves with the number of blocks.

Fig. 5 illustrates the BER versus SNR with $M = 4$ and $N = 64$. It is obvious that significant performance gain can be obtained through cooperative communication. Besides, a perfect match can be observed between the theoretical and simulation

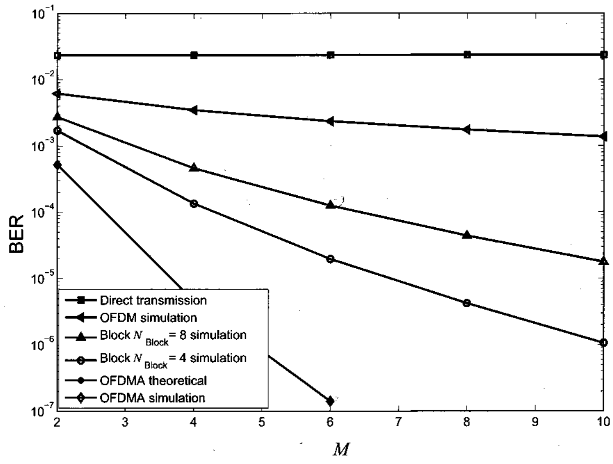

Fig. 6. BER versus the number of relays with $\gamma = 10$ and $N = 64$.

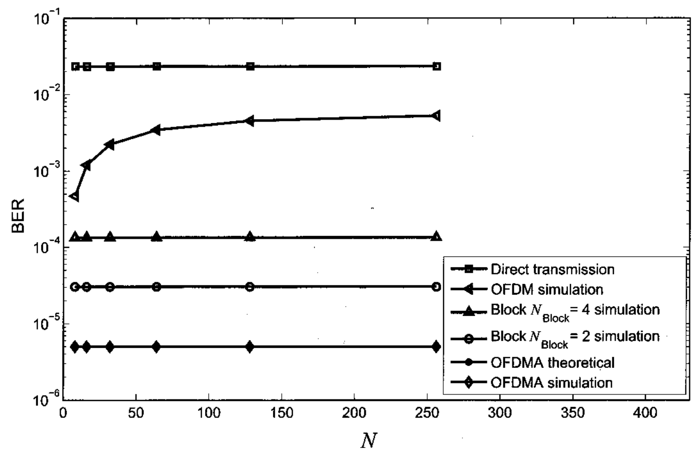

Fig. 7. BER versus the number of subcarriers with $\gamma = 10$ and $M = 4$.

results of selective OFDMA relaying, which can be granted as the lower bound of the BER of the three schemes. As expected, the BER performance of selective block relaying is located between that of selective OFDM relaying and selective OFDMA relaying. We can also find that the BER performance improves with the number of blocks.

Fig. 6 illustrates the BER versus the number of relays with $\gamma = 10$ and $N = 64$. We can see that the BER performance of all the three selective relaying schemes improves exponentially with the increase of the number of relays. Besides, a perfect match can be observed between the theoretical and simulation results of selective OFDMA relaying. As expected, the BER performance of selective block relaying is located between that of selective OFDM relaying and selective OFDMA relaying. We can again observe that the BER performance improves with the number of blocks.

Fig. 7 illustrates the BER versus the number of subcarriers with $\gamma = 10$ and $M = 4$. We can see that the BER performance of selective OFDM relaying degrades with the increase of the number of subcarriers while the BER performance of direct transmission, selective OFDMA relaying and selective block relaying do not change with the number of subcarriers. Besides, a perfect match can be observed between the theoretical and sim-

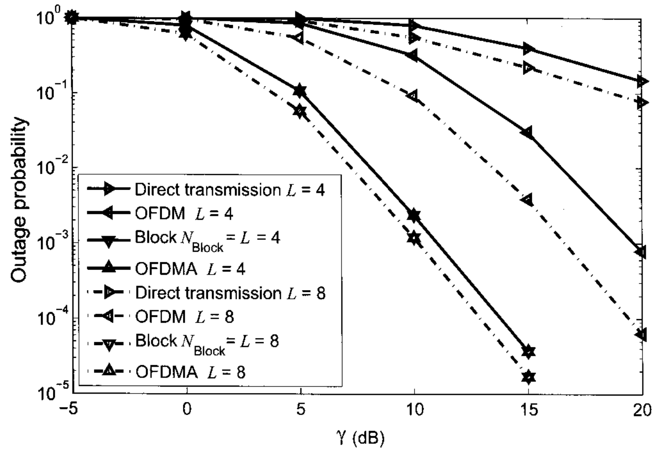

Fig. 8. Outage probability versus SNR in the presence of correlation among the adjacent subcarriers with $M = 4$ and $N = 64$.

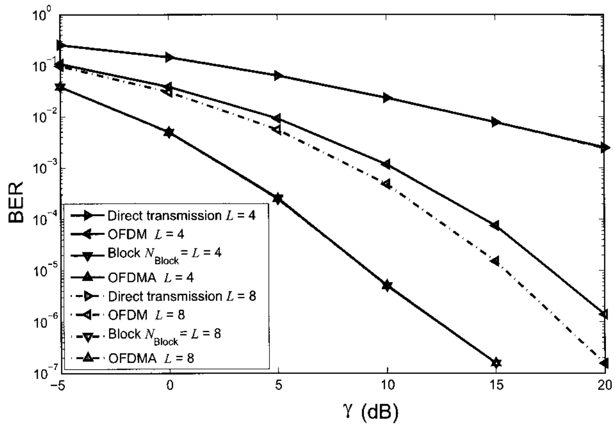

Fig. 9. BER versus SNR in the presence of correlation among the adjacent subcarriers with $M = 4$ and $N = 64$.

ulation results of selective OFDMA relaying. As expected, the outage performance of selective block relaying is located between that of selective OFDM relaying and selective OFDMA relaying. We can also observe that the outage performance improves with the number of blocks.

In the simulations above, we assume that there is no correlation among the adjacent subcarriers and the channels of all the subcarriers are considered to be independent. In fact, correlation usually exists among the adjacent subcarriers, which can be measured by the coherence bandwidth of the OFDM channel. We will now look into the effect of the coherence bandwidth on the proposed scheme. Without loss of generality, we assume that correlation exists among L adjacent subcarriers. In other words, the coherence bandwidth is assumed to be $L\Delta f$ with Δf being the subcarrier spacing of the OFDM symbol.

Fig. 8 illustrates the outage probability versus SNR in the presence of delay spread with $M = 4$ and $N = 64$. We can see that selective block relaying can obtain the same performance as selective OFDMA relaying by setting $N_{\text{Block}} = L$. Therefore, when correlation is present among the adjacent subcarriers, relay selection need not be performed on a per-subcarrier basis. The best performance can be obtained by dividing the OFDM symbol into N/L blocks and performing relay selection on a per-block basis. Besides, it is observed that the outage performance improves with the increase of L. This can be explained intuitively. L adjacent subcarriers which are correlated can be granted as a new subcarrier, and the OFDM symbol can thus be considered to be consisted of N/L independent subcarriers. That is to say, the larger L is, the fewer independent subcarriers the OFDM symbol is consisted of. As has been shown above, the outage performance degrades with the increase of the number of subcarriers. Therefore, the outage performance improves with L.

Fig. 9 illustrates the BER versus SNR in the presence of delay spread with $M = 4$ and $N = 64$. We can see that selective block relaying can obtain the same performance as selective OFDMA relaying by setting $N_{\text{Block}} = L$. Therefore, when correlation is present among the adjacent subcarriers, relay selection need not be performed on a per-subcarrier basis. The best performance can be obtained by dividing the OFDM symbol into N/L blocks and performing relay selection on a per-block basis. Besides, it is observed that the BER performance of selective OFDM relaying improves with L while the BER performance of direct transmission, selective OFDMA relaying and selective block relaying do not change with L. This can be explained intuitively. L adjacent subcarriers which are correlated can be granted as a new subcarrier, and the OFDM symbol can thus be considered to be consisted of N/L independent subcarriers. That is to say, the larger L is, the fewer independent subcarriers the OFDM symbol is consisted of. As has been shown above, the BER performance of selective OFDM relaying degrades with the increase of the number of independent subcarriers while the BER performance of direct transmission, selective OFDMA relaying and selective block relaying do not change with the increase of the number of independent subcarriers. Therefore, the BER performance of selective OFDM relaying improves with L while the BER performance of direct transmission, selective OFDMA relaying and selective block relaying do not change with L.

VII. CONCLUSIONS

In this paper, we proposed a block-based selective OFDM decode-and-forward relaying scheme for 4G mobile communication systems. Theoretical outage performance and error performance were analyzed and evaluated. A unified outage expression was given for our scheme and the other two schemes and the lower bound of the BER of the three schemes was also obtained. Monte Carlo simulations validated our analysis and showed that the proposed scheme could obtain a good tradeoff between complexity and performance. Besides, the effect of the coherence bandwidth on the proposed scheme was investigated. We found that the outage performance of the proposed scheme improves with the coherence bandwidth while the error performance of the proposed scheme does not change with the coherence bandwidth. It was also found that the block length should be determined according to the coherence bandwidth of the channel. Specifically, the larger the coherence bandwidth is, the larger the block length should be.

We focus on the performance analysis of OFDM based cooperative wireless networks with only relay selection in this paper. Our future work will consider relay selection, power allocation, and subcarrier allocation jointly and analyze the performance therein for OFDM based cooperative wireless networks.

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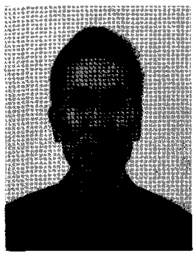

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