Reverse Link Performance of Site Diversity based Transmit Power Control with Antenna Diversity and Rake Combining in DS-CDMA Mobile Radio

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1. Introduction

In DS-CDMA cellular system, near-far problem is a major setback in achieving the desired capacity for the reverse link. Fast transmit power control (TPC) is a key technique to mitigate this problem [1], while as a macro diversity scheme, site diversity has been proven to be another way to improve the received signal quality. In this paper, we introduce an advanced form of reverse link TPC that combines together the aforementioned two techniques and evaluate the reverse link capacity by Monte Carlo numerical computation.

2. Site Diversity based Fast TPC

In this paper, it is assumed that the service area of a DS-CDMA cellular system consists of non-sectorized hexagonal cells where each cell has a base station (BS) in its center. Each mobile terminal (MT) periodically creates an active set of K BS's based on average channel gain which is the multiplication of distance dependent path loss and log-normally distributed shadowing loss. Throughout the duration of a call, the MT selects the best Q BS's ($Q \le K$) from this active set based on instantaneous channel gain that considers path loss, shadowing loss and multipath fading. Reverse link signals from those selected BS's are coherent-rake combined at the radio network control center (RNC), while the transmit power of each MT is controlled to keep the combined received signal power always at a prescribed target level (fast TPC).

3. Numerical Results

Employing Monte Carlo numerical method, the reverse link capacity is measured. The short term bit error rate (BER) averaged over the multipath fading statistics is calculated for rake combining based on maximal ratio combining (MRC) [2]. The probability of this BER failing to achieve the required BER is called the outage probability. The link capacity is defined as the maximum number of users that can communicate under the allowable outage probability (AUP).

Table 1 shows the simulation conditions used in the Monte Carlo numerical computation. M-antenna diversity reception at each BS is considered. The propagation channel consists of L discrete propagation paths each being subjected to independent Rayleigh fading. In Fig. 1, the outage probability is plotted against the number of active users per cell. Incorporating fast TPC in site diversity gives significant improvement in link capacity. Moreover this site diversity with fast TPC can be classified as selection combining (SC) based site diversity for Q=1, and MRC based site diversity for Q>1, where the latter gives better performance. Here each Q is plotted with different values of K such as 1, 2, 3 and 7 and it is found that for SC and MRC scheme, the number K, that satisfies the conditions $K \ge 2$ and $K \ge Q$ respectively, has a very little effect on the reverse link capacity. It indicates that for a certain Q, almost the same performance can be accomplished from MRC based site diversity that selects only Q BS's based on average channel gain and combine them by the aforementioned way. From the context of system implementation it might be an important result to be considered.

Table 1. Simulation Condition

Modulation scheme	QPSK
Cellular structure	Non-sectorized hexagonal cell
User distribution	Uniform
Path loss exponent (α)	3.5
Standard deviation of shadowing loss (η)	6 dB
Multipath fading channel	L-path Rayleigh fading
Required BER	10^{-2}
Spreading factor	32

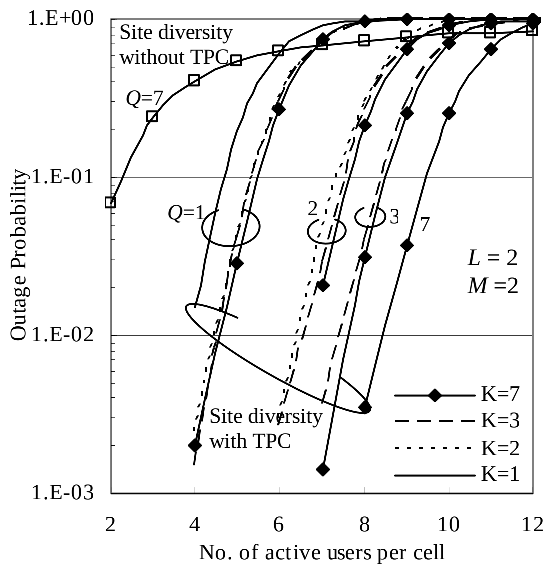

Fig. 1 Outage probability.

4. Conclusion

The effect of site diversity based fast TPC along with two parameters K and Q is evaluated. The increase in the number Q of BS's selected from the active set that participate in the site diversity operation, improves link capacity regardless of the value of K ($K \ge Q$). The capacity improvement from Q=1 to Q=7 is about 75%, while the latter can accommodate as many users as 30% of spreading factor in case of AUP=0.1.

5. Reference

[1] A. J. Viterbi, *CDMA: Principles of Spread Spectrum Communications*, Addison-Wesley, June 1995.
[2] J. G. Proakis, *Digital Communications*, 3rd ed., New work, McGraw Hill, 1995.