System Performance Analysis for MC-CDMA Systems over Correlated-Gaussian Fading Branch

劉昱吟、陳雍宗

E-mail: 9511022@mail.dyu.edu.tw

ABSTRACT

本論文旨在研究MC-CDMA（multi-carrier coded-division multiple-access）系統工作於不相關（uncorrelated）與相關（correlated）衰落通道的Nakagami-m統計分佈。其中相關分支假設呈現高斯相關（correlated Gaussian）模型，在MC-CDMA系統中，其接收方法採用二位元相移鍵（binary phase shift keying, BPSK）、非同調頻移鍵（noncoherent frequency shift keying, NCFSK）以及差分同調相移鍵（differential coherent phase shift keying, DCPSK）等調變架構，並分析位元錯誤率(bit error rate，BER)效能。為了得到分支之間任意相關通道的完全式，本文採用Gamma變數的機率密度函數(probability density function, pdf)，以避免在最大比例合成(maximal ratio combining，MRC)輸出，求得SNR(signal-to-noise ratio)之機率密度函數的困難。由本文所分析之系統BER效能得知，MC-CDMA系統極易受衰落通道相關性影響的，就MC-CDMA系統的BER效能而言，考慮無相關分支與相關分支的現象時，兩者之間約有3dB以上之差異。

Keywords : MC-CDMA system, uncorrelated channels, correlated channels, Nakagami-m fading statistics, MRC diversity

Table of Contents

REFERENCES

[1] L. B. Milstein, “ A Conceptual Overview of Wideband Code Division Mulitple Access ”, IEEE Sixth International Symposium on Spread Spectrum Techniques and Applications, Vol. 1, pp. 226-229, 2000.

[2] R. Esmailzadeh and M. Nakagawa, “ TDD-CDMA for the 4th Generation of Wireless Communications ”, IEEE Wireless Commun., Vol. 10,

No. 4, pp. 8-15, 2003.
[3] S. Kondo and L. B. Milstein, “ Multicarrier CDMA System with Cochannel Interference Cancellation ” , Proc. Vehicular Technology Conferenc ’ 94, pp. 640-1644, 1994.
[4] N. Yee, J. -P. Linnartz, and G. Fettweis, “ Multi-carrier CDMA in Indoor Wireless Radio Networks ” , IEICE Trans. on Commun., Vol. E77-B, No.7, pp. 900-904, 1994.
[5] S. Kondo, L. B. Milstein, “ On the Performance of Multicarrier DS-CDMA Systems ” , IEEE Trans. on Commun., pp. 3101, 1995.
[6] S. Hara and P. Ramjee, “ Design and Performance of Multicarrier CDMA System in Frequency-Selective Rayleigh Fading Channels ” , IEEE Trans. on Vehicular Technology Vol. 48, No. 5, pp. 1584-1595, 1999.
[7] D. N. Rowitch and L. B. Milstein, “ Coded Multicarrier DS-CDMA in the Presence of Partial Band Interference ” , Proc. MILCOM ’ 96, Vol. 1, pp. 204-209, 1996.
[8] W. Xu and L. B. Miltstein, “ On the Performance of Multicarrier RAKE Systems ” , Proc. GLOBECOM ’ 97, Vol. 1, pp. 295-299, 1997.
[9] M. K. Simon, M. – S. Alouini, “ BER Performance of Multicarrier DS-CDMA System over Generalized Fading Channels ” , Communication Theory Mini-Conference, pp. 72-77, 1999.
[10] R. E. Ziemer, “ Effect of Correlation Between Subcarrier of an MCM/DSSS Communication System ” , Vehicular Technology Conference, 'Mobile Technology for the Human Race', IEEE 46th , Vol. 1 , pp. 146-150, 1996.
[11] Zexian Li, M. Latva-aho, “ Error Probability for MC-CDMA in Nakagami-m Fading Channels Using Equal Gain Combining ” , IEEE International Conference on Commun, Vol. 1, pp. 227-231, 2002.
[12] Q. Shi , M. Latva-aho, “ Performance Analysis of MC-CDMA in Rayleigh Fading Channels with Correlated Envelopes and Phases ” , IEE Proc -Commun, Vol. 150, No. 3, pp. 214-220, 2003.
[13] Taeyoung Kim, et. al, “ Performance of an MC-CDMA System with Frequency Offsets in Correlated Fading ” , IEEE International Conference on Commun, Vol. 2, pp. 1095-1099, 2000.
[14] Junhyun Park, et. al., “ Performance of MC-CDMA Systems in Non-independent Rayleigh Fading ” , IEEE International Conference on Commun, Vol. 1, pp. 506-510, 1999.
[15] W. Xu, L. B. Milstein, “ Performance of Multicarrier DS-CDMA Systems in the Presence of Correlation Fading ” , Vehicular Technology Conference, IEEE 47th, Vol. 3, pp. 2050-2054, 1997.
[16] Qinghua shi, M. Latva-aho, “ Exact Error Floor for Downlink MC-CDMA with Maximal Ratio Combining in Correlated Nakagami Fading Channels ” , International Zurich Seminar on Broadband Communications. Access-transmission, Networking, Eth Zurich SW, pp. 37-1-37-5, 2002.
[17] Chan Kyu Kim, and Yong Sos Cho, “ Performance of a Wireless MC-CDMA System with an Antenna Array in a Fading Channel: Reverse Link ” , IEEE Trans. on Commun, Vol. 48, No. 8, pp. 1257-1261, 2000.
[18] S. Abeta, H. Atarashi, and M. Sawahashi, “ Forward Link Capacity of Coherent DS-CDMA and MC-CDMA Broadband Packet Wireless Access in a Multi-cell Environment ” , IEEE Vehicular Technology Conference, Vol. 5, pp. 2213-2218, 2000.
[19] Hongnian Xing, and Markku Renfors, “ The Performance Evaluation of the Multi-Carrier CDMA System with Frequency Domain Equalization ” , IEEE Vehicular Technology Conferenc, Vol. 4, pp. 2362-2366, 1999.
[20] S. Sigdel et. al., “ Performance Evaluation of Multicarrier CDMA Uplink System with Antenna Array and Multiuser Detection over Correlated Multipath Channel ” , IEEE Vehicular Technology Conference, Vol. 4, pp. 1958-1962, 2002.
[21] David J. Sadler, and A. Manikas, “ Reduction of Intracell and Intercell Interference for Array MC-DS-CDMA ” , IEEE Global Telecommunications Conference, Vol. 4, pp. 2167-2171, 2003.
[22] Merouane Debbah, “ Capacity of a Downlink MC-CDMA Multi-cell Network ” , IEEE International Conference on Acoustics, Speech, and Signal Processing, Vol. 4, pp. IV-761-I-764, 2004.
[23] E. A. Sourour and M. Nakagawa, “ Performance of Orthogonal Multicarrier CDMA in a Multipath Fading Channel ” , IEEE Trans. on Commun., Vol. 44, pp. 356-367, 1996.
[24] Matthias Patzold, “ Mobile Fading Channel ” , Wiley, pp. 3-7, 2002.
[25] S. Bernard, “ Digital Communications Fundamentals and Applications ” , Prentice Hall International, Inc, pp. 962-966, 2001.
[26] T. S. Rappaport, “ Wireless Communications Principles and Practice. Prentice Hall PTR, New Jersey, 1996.
[27] B. Sklar, “ Rayleigh Fading Channels in Mobile Digital Communication Systems Part 1: Characterization ” , IEEE Commun. Magazine, pp. 90-100, 1997.
[28] B. Sklar, “ Digital Communications:Fundamental and Applications ” , Prentice-Hall PTR, New Jersey, 1988.
[29] K. Feher, “ Wireless Digital Communications:Modulation and Spread Spectrum Applications ” , Prentice Hall PTR, New Jersey, 1995.
[30] J. G. Proakis, “ Digital Communications ” , 3rd ed., McGraw-Hill, New York, 1995.
[31] Yacoub, M. D., “ Foundations of Mobile Radio Engineering ” , CRC Press Inc, 1993.
[32] Mondre, E., “ Complex and Envelope Covariance for Rician Fading Communication Channels Communications ” , IEEE Trans. [legacy, pre - 1988], Vol. 19, Issue: 1, pp. 80-84, 1971.

[33] D. Middle, “ An Introduction to Statistical Communication Systems and Techniques ” , New York:McGraw-Hill, 1966.
[34] Suzuki, H., “ A Statistical Model for Urban Radio Propagation ” , IEEE Trans. on Commun., Vol. 27, No. 4, pp. 657-670, 1979.
[35] Nakagami, M., “ The m-Distribution-A General Formula of Intensity Distribution of Rapid Fading ” , Statistic Methods of in Radio Wave Propagation, Pergamon Press, New York, pp. 3-36, 1960.
[36] I. S. Gradshteyn and I. M. Ryzhik, “ Table of Integrals, Series, and Products ” , 5th ed. New York:Academic, 1994.
[37] M. K. Simon and M. – S. Alouini, “ Digital Communications over Generalized Fading Channels:A Unified Approach to Performance Analysis ” , Wiley, New York, 2000.
[38] C. C. Tan and N. C. Beaulieu, “ Infinite Series Representation of the Bivariate Rayleigh and Nakagami-m Distributions ” , IEEE Trans. on Commun., Vol. 45, pp. 1159-1161, 1997.
[39] P. G. Moschopoulos, “ The Distribution of the Sum of Independent Gamma Random Variables ” , Ann. Inst. Statist. Math. (Part A), Vol. 37, pp. 541-544, 1985.
[40] M. – S. Alouini, A. Abdi, and M. Kaveh, “ Sum of Gamma Variates and Performance of Wireless Communication Systems over Nakagami-Fading Channels ” , IEEE Trans. on V. T., Vol. 50, No. 6, pp. 1471-1480, 2001.
[41] P. Lombardo et al., “ MRC Performance for Binary Signals in Nakagami Fading with General Branch Correlation ” , IEEE Trans. on Commun., Vol. 47, No. 1, pp. 44-52, 1999.
[42] M. Schwartz, W. R. Bennett, and S. Stein, “ Communication Systems and Techniques ” , McGraw-Hill: New York, 1966.
[43] Z. Li, and M. Latva-aho, “ Error Probability for MC-CDMA in Nakagami-m Fading Channels Using Equal Gain Combining ” , IEEE International Conference , Vol. 1, pp. 227-231, 2002.
[44] Z. Li, and M. Latva-aho, “ Analysis of MRC Rceivers for Asynchronous MC-CDMA with Channel Estimation Errors ” , IEEE Seventh International Symposium Spread Spectrum Techniques and Applications, Vol. 2, pp. 343-347, 2002.
[45] M. K. Simon and M. – S. Alouini, “ A Unified Approach to the Performance Analysis of Digital Communication over Generalized Fading Channels ” , Proc. of the IEEE, Vol. 86, pp. 1860-1877, 1998.