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Performance Analysis of MC_CDMA over Different Fading Channels

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Abstract*— Multi-Carrier Code Division Multiple Access (MC-CDMA) is one of the recent technologies to support multiple users with high speed data communications in advanced wireless systems. This paper specially analyzes the BER performance under Rayleigh and Rician fading channel conditions of MC-CDMA in presence of AWGN (Additive White Gaussian Noise) using BPSK modulation using MATLAB program, and finally the paper also presents a comparison between simulated results, which shows the reduction in BER performance.

Keywords*— MCCDMA, CDMA, OFDM, Rayleigh Fading, Rician Fading.

I. INTRODUCTION

One of the most recent technologies to support multiple users with high speed data communications in advanced wireless systems is Multi-Carrier Code Division Multiple Access (MC-CDMA). Multicarrier code division multiple access is an attractive choice for high speed wireless communication as it mitigates the problem of inter symbol interference and also exploits frequency diversity. In order to support multiple users with high speed data communications, the MCCDMA technique is used to address these challenges. MC-CDMA is a combination of OFDM and Code Division Multiple Access (CDMA) and has the benefits of both systems [2].

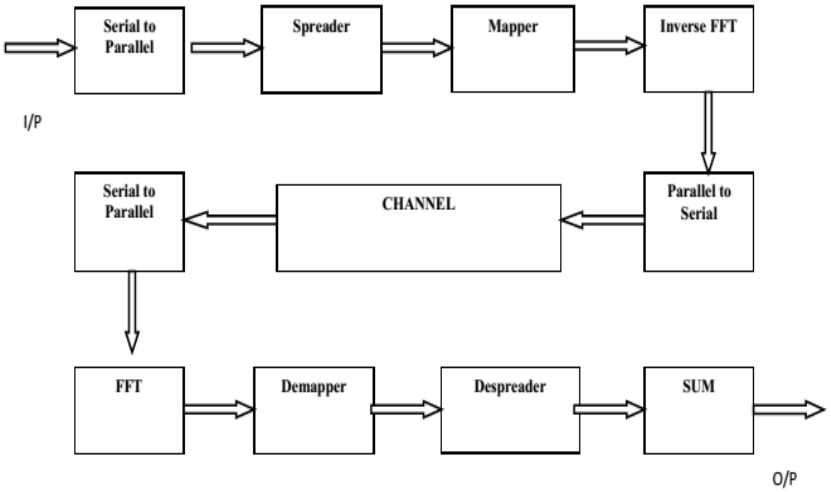

Fig. 1 General MC-CDMA system block diagram

In MC-CDMA, symbols are modulated on many subcarriers to introduce frequency diversity instead of using only one carrier like in CDMA. Thus, MC-CDMA is robust against deep frequency selective fading compared to DS-CDMA. Each user data is first spread using a given high rate spreading code in the frequency domain. A fraction of the symbol, corresponding to a chip of the spreading code, is transmitted through a different subcarrier.

The various advantages of MC-CDMA are listed below:

- High efficiency and flexibility in spectrum usage. This means that others users are allowed to use the spectrum or sub-carriers in the MC-CDMA design if it is not used by 10 the current user. However, it thus introduces complexity in the system in terms of assigning proper spreading codes and reassigning them to the correct users.
- MC-CDMA is robust to frequency selective fading. This is because the symbol period is larger than the delay spread resulting in no ISI.
- The MC-CDMA has a uses simple transmitter and receiver designs with the addition and usage of FFT and IFFT. This opens the systems to a wide variety of applications.
- Capable of providing bit rates up to 100 Mbps, it is a leading candidate for $G wireless communication systems.
- MC-CDMA can also be adopted effectively for critical real-time applications such as telemedicine and space communications.

II. MULTIPATH FADING

The nature of the radio channel affects the transmission of the information through it. One of the major challenges facing engineers in mobile radio design has been modelling an accurate radio channel and its characteristics. Environmental properties affecting the radio channel include Urban/Hilly/Rural terrain, indoor/outdoor environment and weather conditions including humidity factor. Depending on the received signal level, channels can have fast or slow fading. If the local average of signal varies slowly with displacement, large scale fading occurs. If there are rapid changes to the signal with small displacements, small scale fading occurs. Depending on the frequency range, the radio channel types may vary [7].

III. MC-CDMA IMPLEMENTATION

OFDM is an extremely successful technology in dealing with frequency selective fading and intersymbol interference. It is robust in multipath mobile environments and is tolerant to delay spreading. The transmitter section of MC-CDMA is shown in fig. 2.

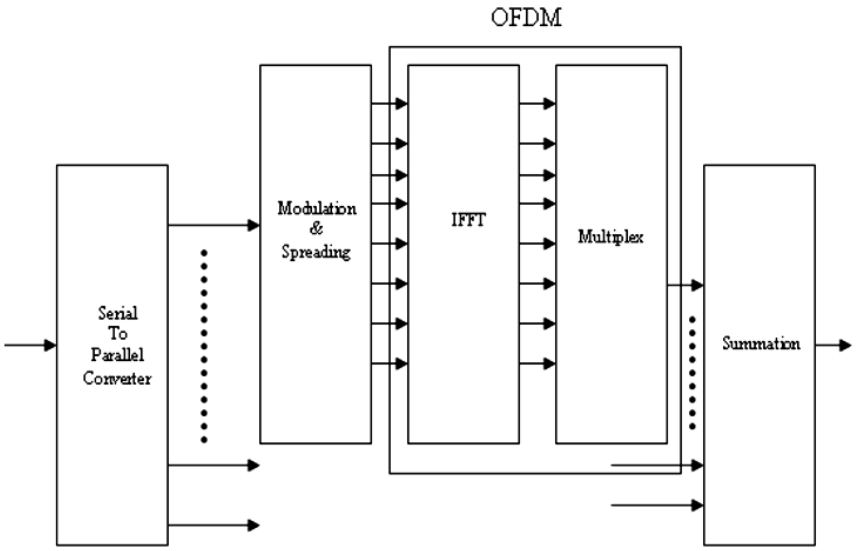

Fig. 2 MC-CDMA Transmitter Implementation

The receiver basically does the reverse operation to the transmitter, fig. 3. An exact inverse of the transmitter is performed at the receiving end. As the first step, the cyclic prefix is removed and sent to the FFT section. The FFT is performed to obtain the signals in the frequency domain. Since the Walsh code of the user is not known at the receiver section, a search operation is done where the received symbols are correlated to the Walsh codes with maximum correlation with the received symbols are chosen.

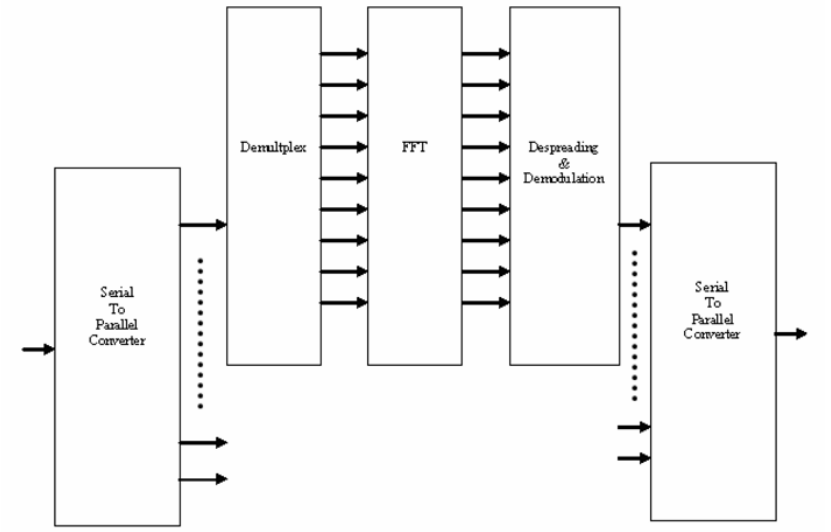

Fig. 3 MC-CDMA Receiver

IV. RESULTS AND DISCUSSIONS

The MC-CDMA system is discussed in chapter III is implemented in various simulation parameters used for the analysis given in table I. The transmitted data bit rate used is of $10^{\wedge 6}$ bits for MC-CDMA transmitter. The simulation is carried to obtain the results as per the objectives defined in chapter III. The BER value of 10^{-3} and 10^{-2} are set as comparison level so as to analyse the performance in wireless environments.

TABLE I SIMULATION PARAMETERS

Contents	Parameters
Channel type	AWGN, Rayleigh, Rician
No. of users	2
Modulation	BPSK
Spreading	Walsh-Hadamard
FFT size	512
CP length	¼
Eb/No (db)	0 to 20

The various results obtained from the simulation are presented next.

A. MC-CDMA in AWGN channel

Figure 4 shows the performance of MC-CDMA system with 4 users in AWGN channel and the theoretical BER for BPSK in AWGN channel. The performance curve shows that MC-CDMA improves the BPSK transmission in AWGN channel.

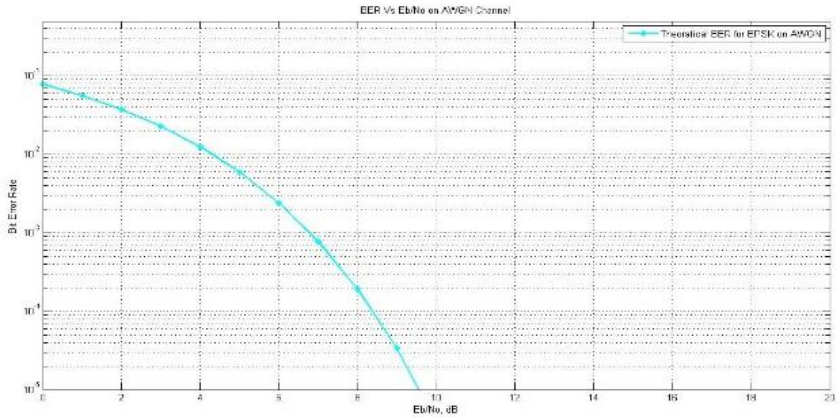

Fig. 4 MC-CDMA theoretical in AWGN channel

B. MC-CDMA in Rayleigh channel

In the next simulation scenario the performance of MC-CDMA is then analysed for wireless environment in fading channel Rayleigh Fading. Figure 5 shows theoretical performance of MC-CDMA in 4 tap Rayleigh channel.

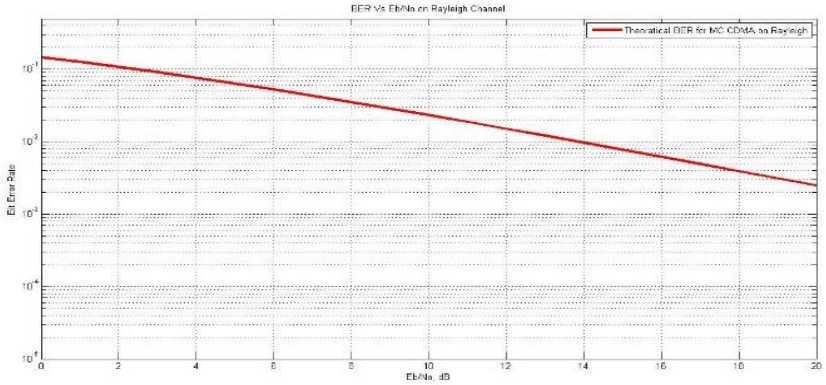

Fig. 5 MC-CDMA in theoretical in Rayleigh channel

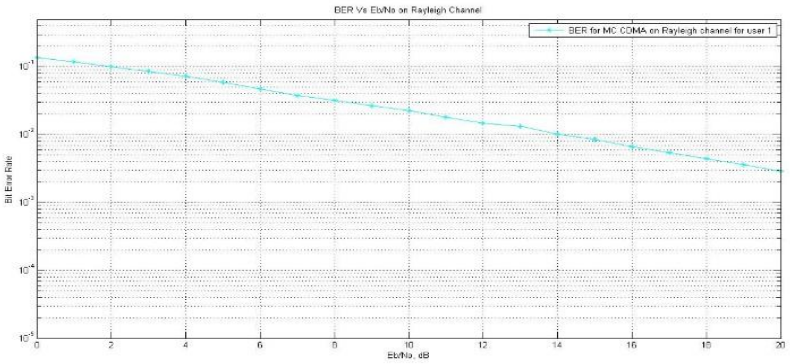

Fig. 6 MC-CDMA in Rayleigh channel for user1

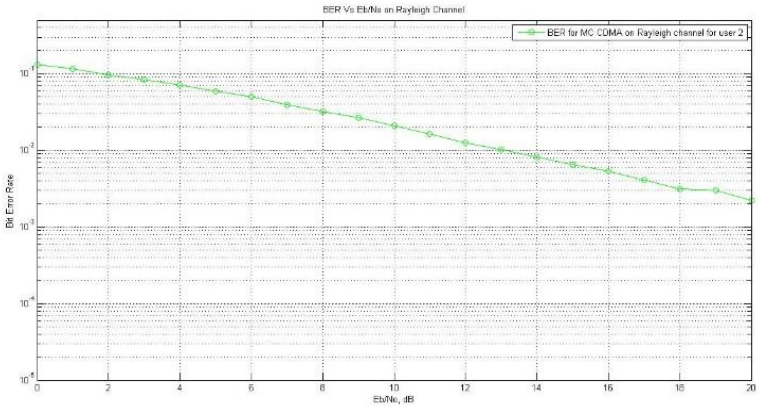

Fig.7 MC-CDMA in Rayleigh channel for user 2

C. MC-CDMA in Rayleigh channel

The performance of MC-CDMA is then analysed for wireless environment in Rician Fading and different fading channels.

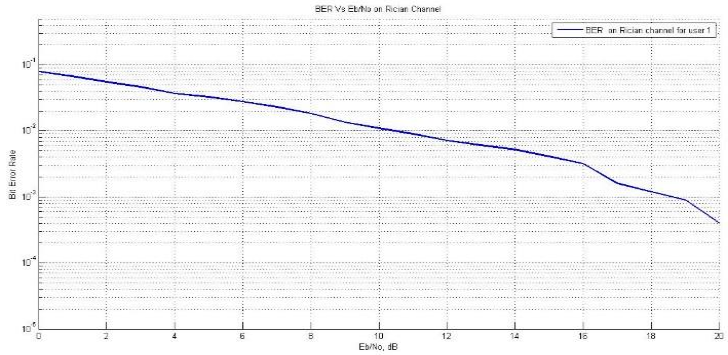

Fig. 8: MC-CDMA performance in Rician channel for user 1

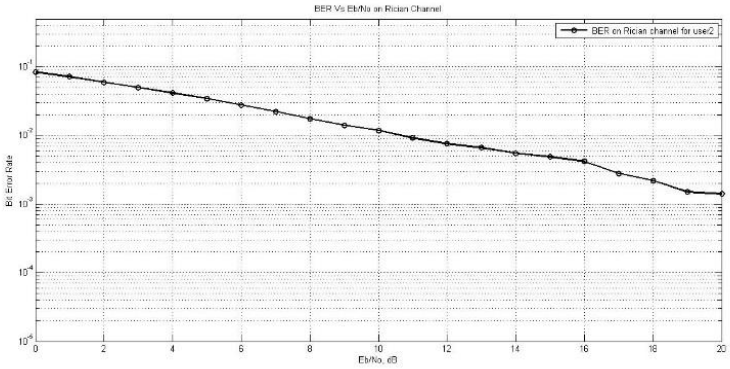

Fig. 9: MC-CDMA performance in Rician channel for user 2

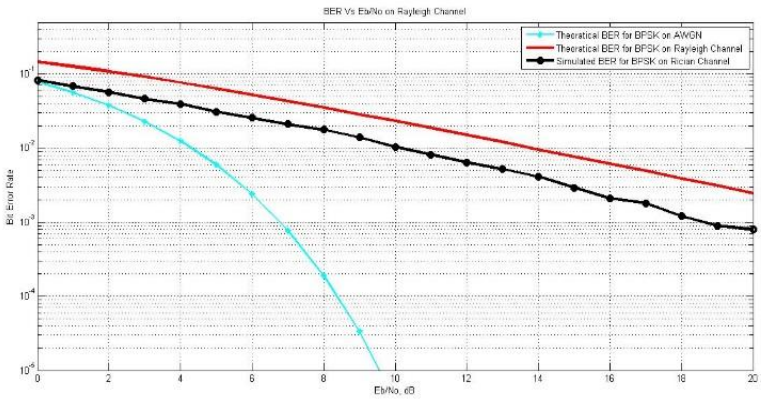

Fig. 10: MC-CDMA performance in different fading channel

V. CONCLUSIONS

The various observations from the results obtained are:

- MC-CDMA has improved performance of BPSK in multipath fading channels as compared with BPSK performance in AWGN channel.
- BER performance of MC-CDMA in Rician channel is lower as compared to Rayleigh channel showing that it has high performance in (Line of Sight) LOS environments. .

The lower BER obtained for MC-CDMA system for these channels show that MC-CDMA reduces the frequency selective fading problem in CDMA; hence it is an ideal candidate for the multipath fading environments.

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REFERENCES

[1] Pragya, P. and Dutta, P. 2010, Muti-Carrier CDMA Overview with BPSK Modulation In Rayleigh Channel; Computer Science and Information Technology (ICCSIT), 2010 3rd IEEE International Conference on, 464 – 469.

[2] Park, Y.; Kim,C.; Cho,K.; Lee,C.; Lee,H.; Kim,J.; Kwak,K. 2004, Performance of UWB DSCDMA/OFDM/MC-CDMA system.; MWSCAS '04 , Vol. 137-40.

[3] Amin, S.A. ; Alam, M. ; Majumder, S.P. 2009 Performance Analysis of Multi-carrier DS- CDMA Wireless Communication System, Computer Modeling and Simulation; Third UK Sim European Symposium.

[4] Faisal M., Haider J., Simulation Based Performance Analysis of MCCDMA and CDMA over Rayleigh Fading Channel", International Journal on Internet and Distributed Computing Systems, vol 2, no 1, 2012, 120- 122.

[5] Rizwan, S. 2011, Effect of using RM code to control PAPR in MCCDMA and OFDM; Multitopic Conference (INMIC), IEEE 14th International.

[6] Ghanim, M.F, Abdullah, M.F.L. 2011, Multi-user MCCDMA using Walsh code for Rayleigh and Gaussianchannel, Research and Development (SCOReD), 2011. IEEE Student Conference on, 58-63.

[7] Theodore S. Rappaport, "Wireless Communications", Prentice Hall, 2000.

[8] Communication Tool Box user guide Matlab (R2009b) .

