IJTNR
International Journal of Technology and Research

Test bench implementation of UMTS

* *Muneer Ahmad*
Department of Physics
Comsats Universty, Islamabad, Pakistan
Muneer0019@gmail.com

***Abstract*— I Nowadays communication systems face several different challenges to integrate and provide wide variety of services such as high speed data rates and multimedia services. This project has focused on the design and development of UMTS (WCDMA physical layer) test bench implemented in MATLAB.**

Keywords- Frequency, Data Rate, Bit Error Rate, WCDMA.rity

I. INTRODUCTION

The aim of this project is to design & implement the test bench of UMTS of the physical layer of UMTS by using specifications given in the release 99 and 5 of 3rd Generation Partnership Project while improving the data rate and lowering the bit error rate by using different techniques such as TDD, FDD, CRC and turbo codes. UMTS (WCDMA physical layer) has been implemented in the MATLAB.

A. Code Division Multiple Access (CDMA)

Code Division Multiple Access is the multiple access technique in which each subscriber is assigned a unique code which is different from the codes of other subscribers.[1] In CDMA all the subscribers are allocated the same available bandwidth. However in CDMA each subscriber is assigned his own code which is used to distinguish him from the message of other subscribers.[5] The systems which employ the CDMA technique employ an orthogonal spreading signal that is uncorrelated to the message signal; it is multiplied with the message signal and hence as a consequence the bandwidth of the multiplied signal is increased. This phenomenon is known as "Direct Sequence Spread Spectrum" (DS-SS). [2]It is the most common method which is employed in CDMA. Probably this has to do with the simplicity with which the DS-SS can be implemented.

B. Direct Sequence Spread Spectrum

The Direct-Sequence Spread Spectrum is one of the most popular and used type of spread spectrum. Probably this has to do with the simplicity with which the DS-SS can be implemented. In this type of modulation a Pseudo-Random noise generator creates a spreading code which is more commonly known as pseudo-noise (PN) code sequence.[7] Each bit of the original data that is given at the input is directly modulated with this PN sequence and is represented by multiple bits in the transmitted signal. On the receiver side only the same PN sequence can be used to demodulate the spread spectrum signal to recover the input data successfully. The bandwidth of the transmitted signal is proportional to the number of bits used in the PN sequence. A 7-bit code sequence spreads the signal on a wider frequency band which is seven times greater that 1-bit code sequence, which can also be described as having a processing gain of seven (7). The DS-SS signal is generated by using an exclusive-OR (XOR) operation. The XOR confirms the conventional rules. When the input data bit is 0, the PN sequence coding bits are transmitted without inversion, whereas when the input data bit is 1, the coding bits are inverted. The input data and PN sequence are converted into bipolar waveform with amplitude values of ±1.

C. Wideband Code Division Multiple Access (WCDMA)

Wideband Code Division Multiple Access is the advanced technique of CDMA. WCDMA is an air interface standard found in 3G mobile telecommunication networks.[6] It is the basis of Japan's NTT DoCoMo's FOMA service and the most-commonly used member of the UMTS family and sometimes used as a synonym for UMTS. It utilizes the DS-CDMA channel access method and the FDD duplexing method to achieve higher speeds and support more users compared to most time division multiple access (TDMA) and time division duplex (TDD) schemes used today.[3]

D. Implementation of physical layer of UMTS (WCDMA)

The project requires programming skills so the physical layer of UMTS(WCDMA) is implemented in MATLAB. Turbo codes, CRC error detection technique, 1/3 convolutional encoder, viterbi decoder has been implemented in MATLAB. In UMTS transmitter implementation, first the input data is generated then it is passed through CRC. The data is passed to the convolutional encoder and then passed on to the interleaver and then the message data is xor-ed with Walsh codes and the PN sequences. The block diagram of the WCDMA transmitter is given below:
WCDMA transmitter block diagram:

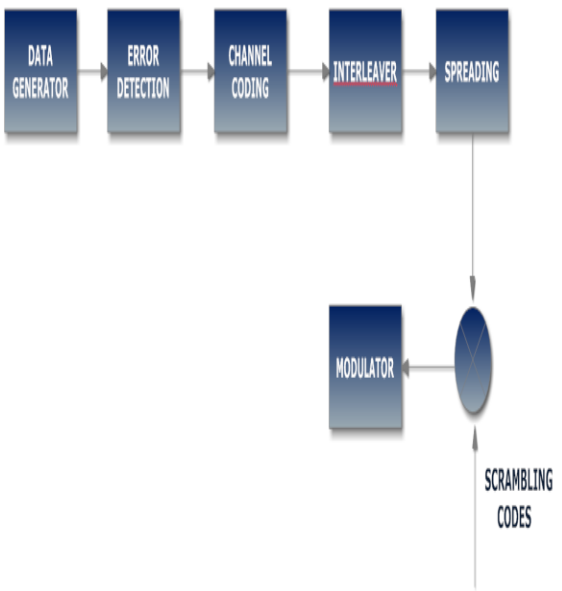


Figure 1: Block diagram

I. WALSH CODES

Walsh codes are orthogonal codes as they have zero cross correlation. Walsh codes are basically used to separate users and forward channels. The code orthogonality is defined as if the product of two signals summed over a period of time is zero then those codes are orthogonal in nature.[4] This project has been implemented by using 64 x 64 walsh code matrices and the 1st row is the pilot channel and rest of the rows represent subscribers. Number of 1's and 0's are equal in each row except the pilot sequence.

II. PN SEQUENCES

PN sequences has been implemented to be used in the scrambling process. Scrambling process is basically used for separating one base station from another base station. Generated by a multibit shift register, where some selected outputs are added modulo 2 and fed back to the input.If there are N shift registers, the length of the PN code is equal to2^N-1.[8]

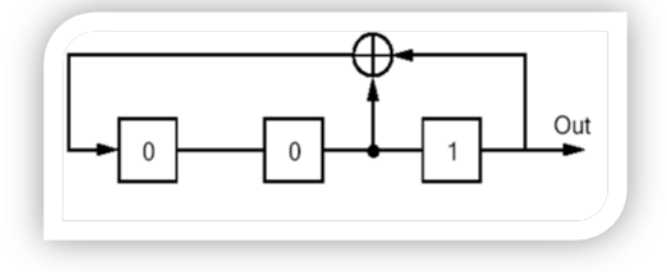


Figure 2: LFSR Implementation

The block diagram of receiver that has been implemented in the project is given below:

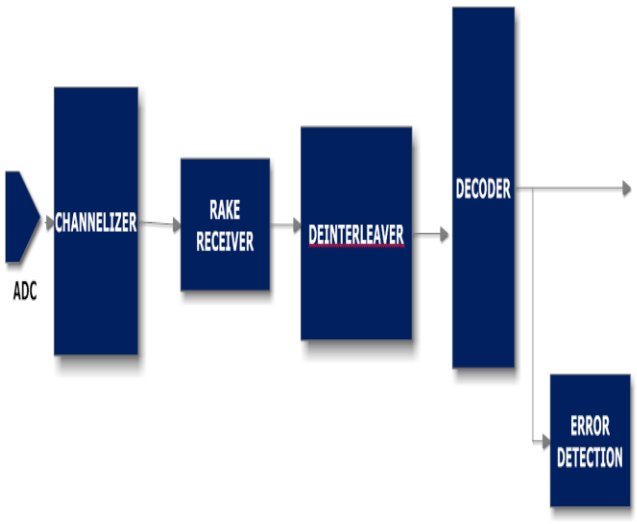


Figure3: Error Detection Block diagram

E. Rake Receiver

The rake receiver is the most important part of the receiver side. Descrambling, dispreading and demodulation takes place in the rake receiver. Rake receiver basically consists of three fingers:
A down sampler
A channel estimator
A phase corrector

F. Results

The different results that were generated after the simulation are given below:

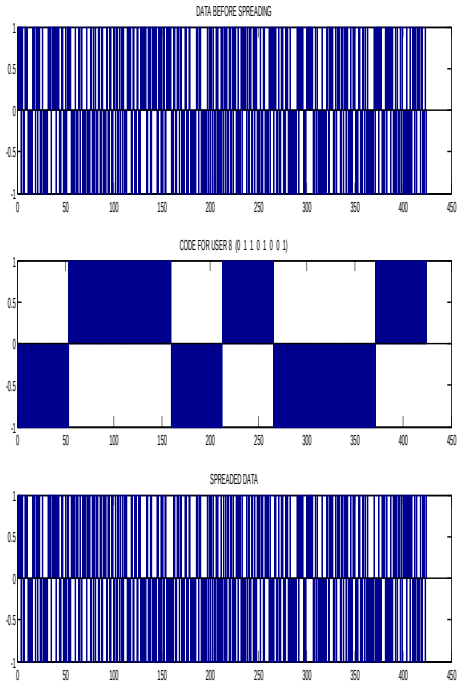
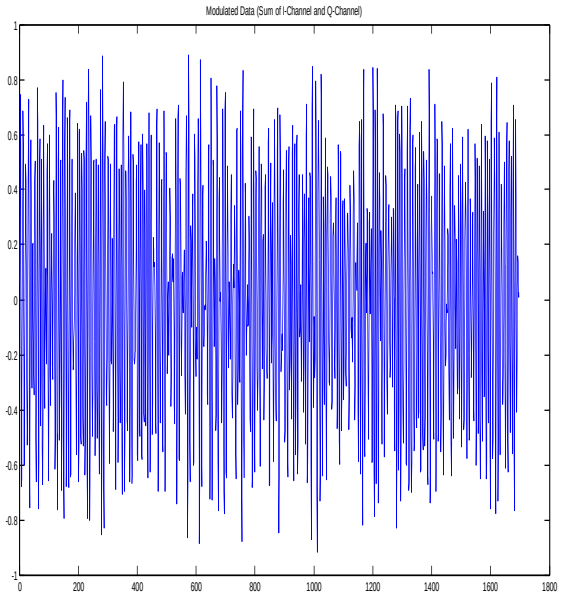


Figure 4: data transmitted



T

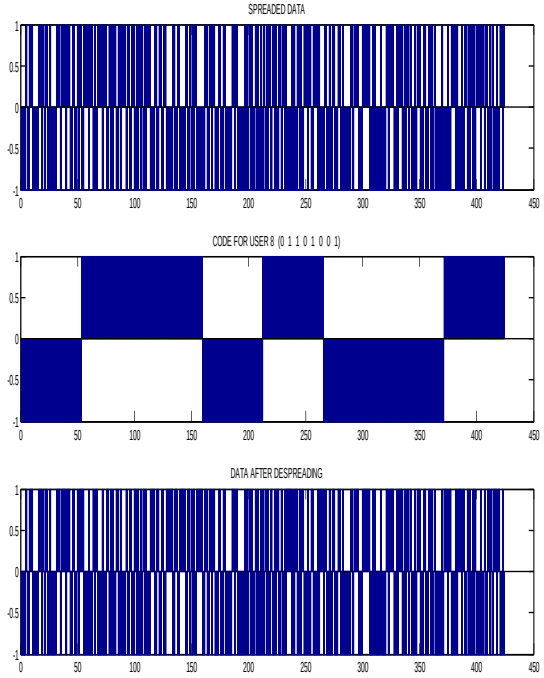


Figure 4: Data Received

BER vs SNR:

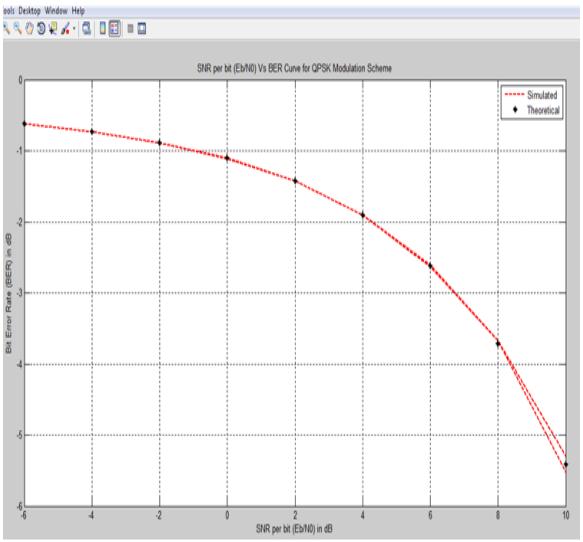


Figure 6: bit error rates

III. CONCLUSION

UMTS can be summarized as a revolution of the air interface accompanied by an evolution of the core network.
Handover and backward compatibility with GSM will ensure that both technologies will coexist for many years.
UMTS networks can be operated with GSM/GPRS networks. Systems use different frequency bands, so BTSs and mobiles will (should) not interfere with each other. Some vendors claim their core network (MSC/HLR/SGSN etc) and BSC/RNC are UMTS compatible, but most operators will prefer to build a totally separate/independent UMTS network. Some of the latest GSM BTSs can also have UMTS radio parts and share the same rack.

References

[1] Karim, M.R., Sarraf, M. "W-CDMA and CDMA2000 for 3G Mobile Networks", McGraw-Hill 2002
[2]Korhonen, JK. "Introduction to 3G Mobile Communications", Second Edition, Artech House Inc. 2003.
[3]J. Yi, C. Lee, F. "UMTS Mobile Communications for the Future", J. Kim& Sons Ltd 2003.
[4]Stallings, W. "Wireless Communications & Networks", Second Edition, Pearson Education, Inc. 2005.
[5]Tachikawa, J. "W-CDMA Mobile Communications System", Richardson's 2004.
[6]Stallings, W. "Data & Computer Communication", Seventh Edition, Prentice Hall 2004.
[7] M. Wrioutius, J. Y. Ramel, and N. Vincent, "WCDMA," in Ninth International Workshop on Frontiers in Handwriting Recognition, pp. 510-516, October 2006.
[8]http://www.ieee.org/web/education/standards/glossary.html