PERFORMANCE EVALUATION OF WCDMA UPLINK SYSTEM OVER DISPERSIVE CHANNEL

MAAN A. S. AL-ADWANY
University of Mosul/ College of Electronics Engineering, Mosul/IRAQ
maanaladwany@yahoo.com

ABSTRACT

In this paper we have simulated and evaluated the performance of WCDMA uplink system for mobile communications over dispersive channel. We have built a simple simulator for WCDMA for UMTS systems. Achievement of simulation has been done by the use of MATLAB. It is found that the dispersive channel affects the system performance drastically, especially by the increase of number of users.

Keywords: *WCDMA, Dispersive Channel, Simulation.*

1. INTRODUCTION

Analog cellular systems are commonly referred to as first generation systems. The digital systems currently in use, such as GSM, PDC, CDMAOne (IS-95) and US-TDMA (IS-136), are second generation systems. These systems have enabled voice communications to go wireless.

Third generation systems are designed for multimedia communication. In the standardization forums, WCDMA technology has emerged as the most widely adopted third generation air interface. Its specification has been created in 3GPP (the 3rd Generation Partnership Project), which is the joint standardization project of the standardization bodies from Europe, Japan, Korea, the USA and China.

WCDMA is a wideband Direct-Sequence Code Division Multiple Access (DS-CDMA) system, i.e. user information bits are spread over a wide bandwidth by multiplying the user data with quasi-random bits (called chips) derived from CDMA spreading codes. In order to support very high bit rates, the use of a variable spreading factor and multicode connections is supported.

The chip rate of 3.84 Mcps leads to a carrier bandwidth of approximately 5 MHz, which is the case for WCDMA systems; while DSCDMA systems with a bandwidth of about 1 MHz, such as IS-95, are commonly referred to as narrowband CDMA systems.

The inherently wide carrier bandwidth of WCDMA supports high user data rates and also has certain performance benefits, such as increased multipath diversity [1].

In this paper we simulate the uplink WCDMA system using MATLAB/SIMULINK. The UMTS communication standards have been deployed. The effect of dispersive channel on system performance has been considered.

2. DESCRIPTION OF WCDMA SYSTEM

In the UMTS systems, and in the uplink communication system; two physical channels are dedicated for every mobile station; the data channel and the control channel. The data channel is used to carry information data like voice, and images, while the control channel is used to carry control signals [2].

A simple schematic diagram for uplink WCDMA system is shown in Fig. 1.

First, the data and control channel bits are modulated using BPSK modulator, and then they are spread with Orthogonal Variable Spreading Factor (OVSF) short codes. After that the two channels are orthogonally related using the complex property. The resultant signal is then scrambled by multiplying with long Golden code. The Golden codes are complex long sequences with low cross correlation, and relatively high autocorrelation [2]. The scrambled signal is then transmitted and propagated over channel.

At the basestation receiver, a reciprocal process is achieved. After descrambling the received signal, the data and control channels are separated simply as shown in Fig. 1. Then a matched filter is used to estimate the transmitted BPSK symbols through the use of integrate and dump (matched filter).

3. SIMULATION OF BASEBAND WCDMA SYSTEM

We have built the baseband WCDMA system using MATLAB/SIMULINK facilities. Fig. 2 illustrates the MATALB simulator which has been built. The simulator consists of number of mobile stations (users), the dispersive channel and/or Additive White Gaussian Noise (AWGN) channel, and the base station receiver. Also, you can observe the Bit Error Rate (BER) calculators that are found already in SIMULINK.

In the implemented simulation model for the baseband WCDMA system, some assumptions have been adopted for the sake of simplicity. So, we have assumed that:

1- One cell model, that is no co-channel interference.
2- Perfect power control, which means that all users have the same signal power at the base station receiver.
3- Every user has its own OVSF and scrambling codes.
4-Full synchronization between the transmitter spreading codes and that at the receiver.

Also, according to the following relation (which is applied in UMTS), some parameters were selected [2]:

Data rate × Spreading factor = Constant = 3.84×10^6 chips/sec.

So, when we select the spreading factor (SF) equal to 8; then the information data must be at a rate of 480 kbps. Also, for SF= 16; the information data rate= 240 kbps.

However, for more informations about UMTS system; reference [2] can be found very useful.

4. RESULTS AND DISCUSSION

After running the simulator, the resulting signal waveforms are displayed for each system stage; by the use of oscilloscope which is already exist at MATLAB/SIMULINK. Fig. 3 illustrates these waveforms and their locations according to Fig. 2.

In our simulation, we have selected the received Bit Error Rate (BER) as a criterion for system performance evaluation. Each result for BER is ensured through running the simulator for about 10^4 symbols.

Fig. 4 shows the variation of received BER with respect to number of users, when the transmitted signal is propagated over dispersive channel; and when propagated over dispersive AWGN channel. The spreading factor (SF) is taken to be equal to (8); hence eight maximum number of users. Also, the information bit rate is 480 kbps.

It is obvious that the BER increases with the increase of number of users because of the increase of number of interferers that act as a deteriorative factor. Also, it is clear that for the same number of users an addition of AWGN will increase the probability of receiving error bits.

The behavior of the system BER over dispersive channel when varying the spreading factor is depicted in Fig. 5. It is noted that the system BER improved when spreading factor increased from 8 to 16 for the same number of users. This can be interpreted as the increase of integration period at the matched filter (integrate and dump), which in turn reduces the effect of possible errors in spreading sequences on the detection process. Also, it can be interpreted as the increasing in SF reduces the noise power per Hertz; which leads to an improvement in SNR at the receiver.

The effect of AWGN variance on the system performance is clarified in Fig. 6. It is observed that the increase in noise variance increases the probability of receiving error bits. Also, the system becomes more robust against noise when increasing the spreading factor.

5. CONCLUSIONS AND SUGGESTIONS

It is concluded that the dispersive channel has a significant deteriorative effect on WCDMA systems and it increases the probability of receiving error bits at receiver, especially when increasing number of users within cell. However, we suggest to overcome the bad effect of dispersive channel through deploying signal processing algorithms at base station receiver.

REFERENCES

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[2] Omer Hazim Salim Al-Taee, “Analysis and Design of Third Generation Cellular System Using Wideband Code Division Multiple Access”, *M.Sc. Thesis, University of Mosul*, 2004.

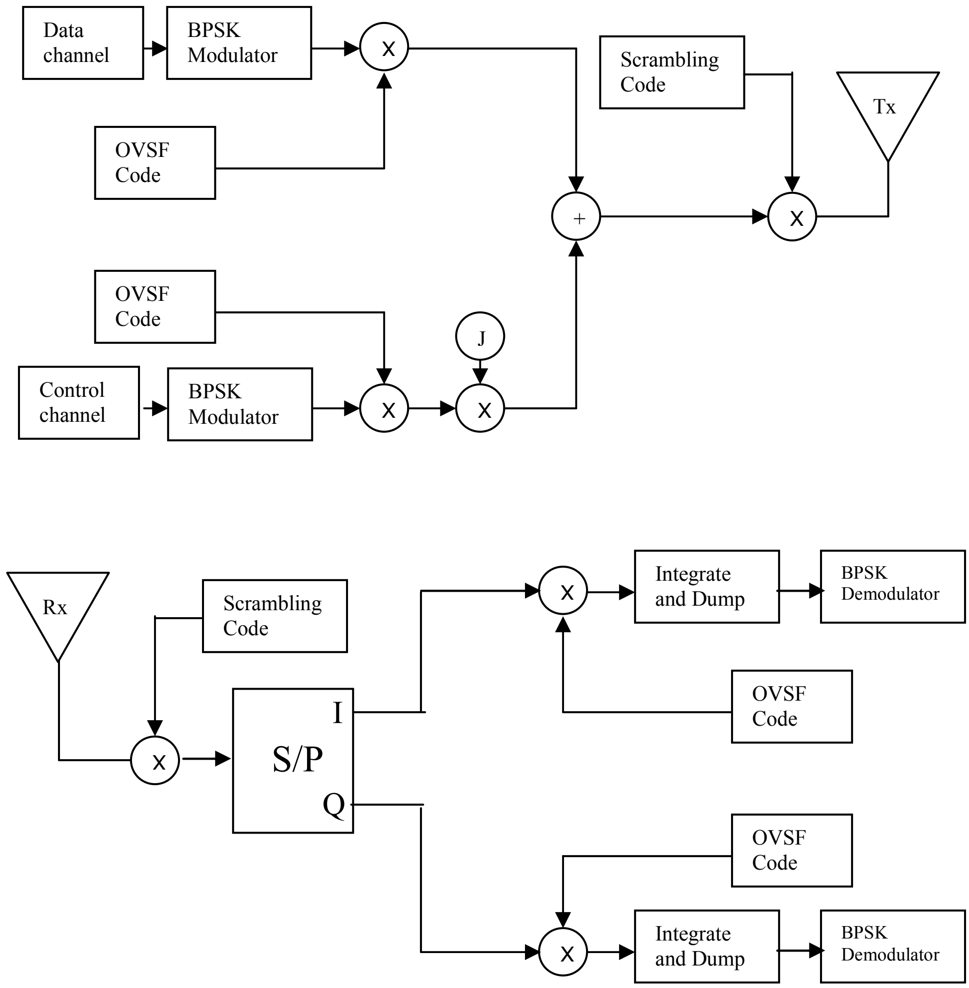

Fig. 1: The WCDMA system.

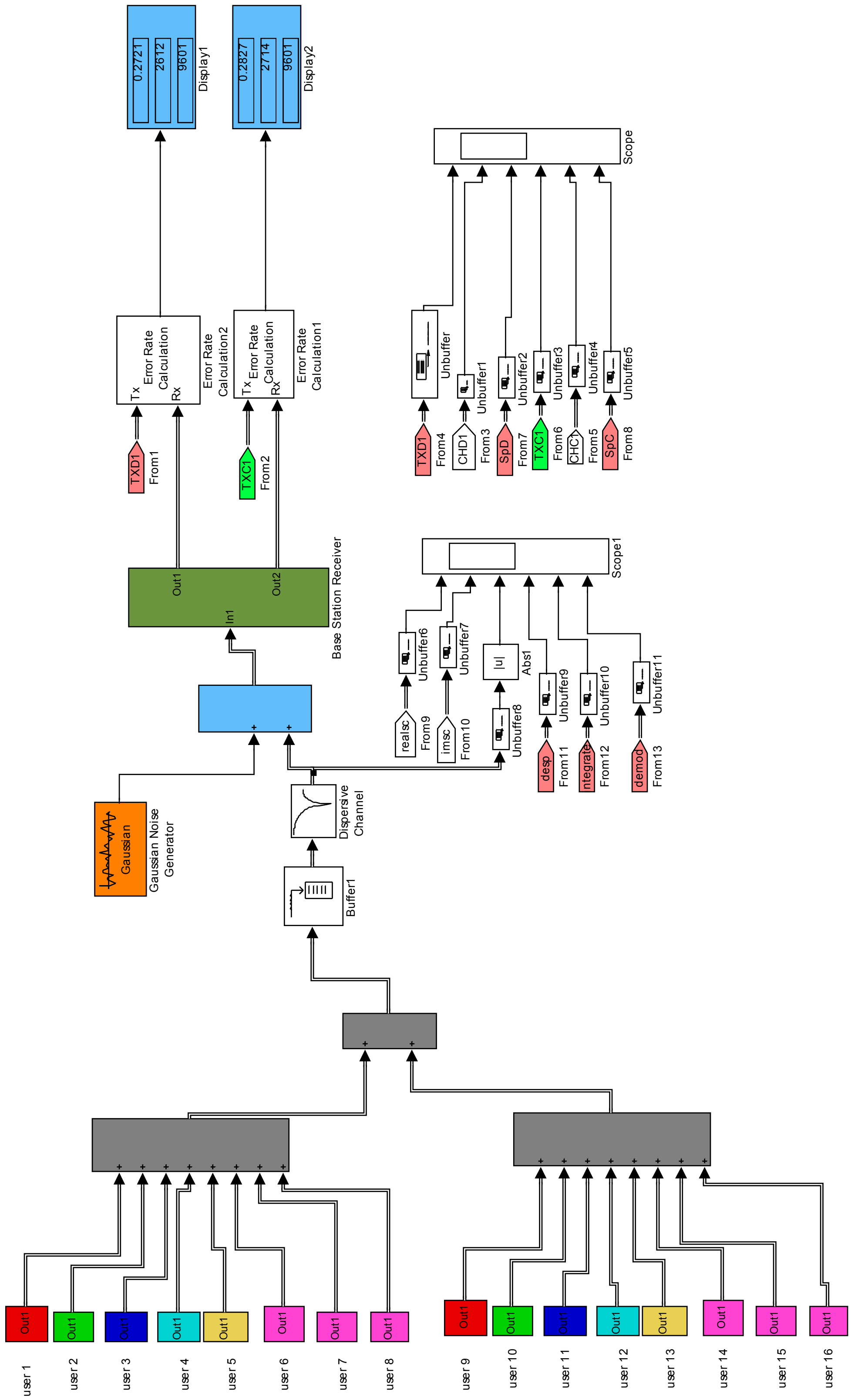

Fig. 2: The Suggested WCDMA System Simulator.

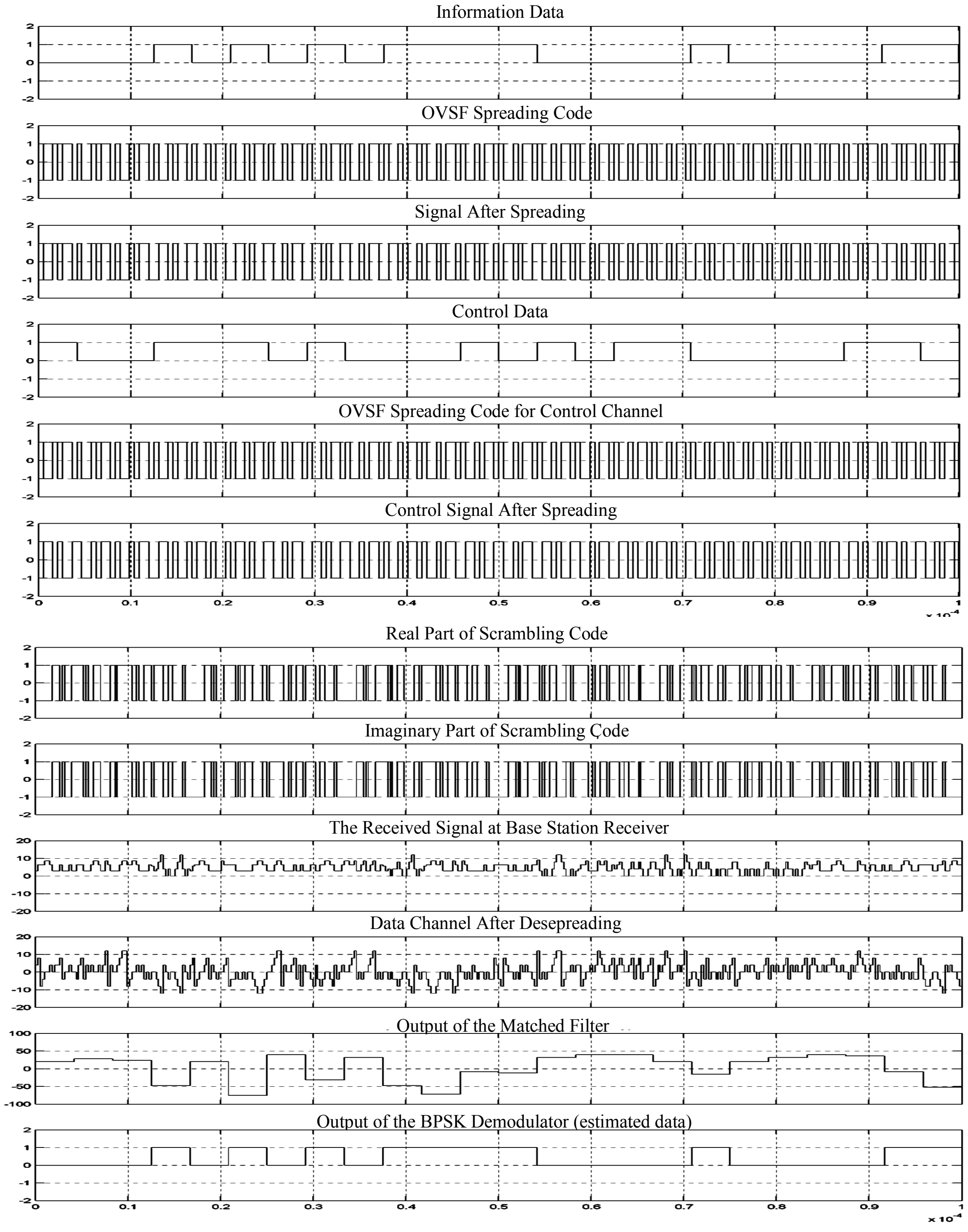

Fig. 3: Signal Waveforms Taken from Selected Test Points.

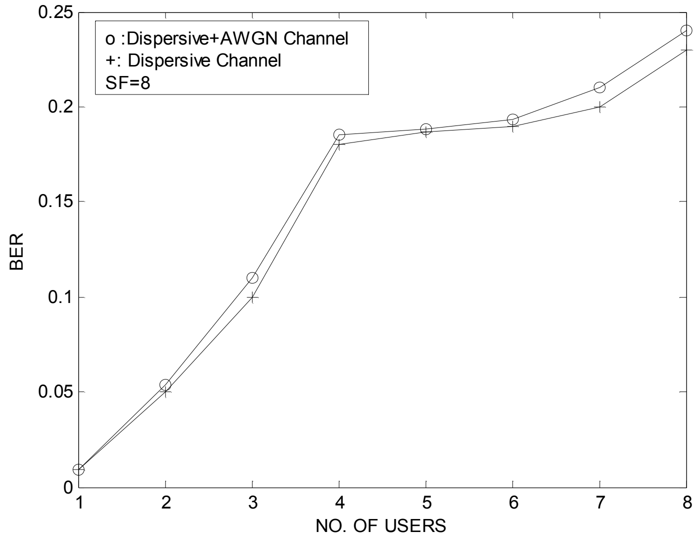

Fig. 4: Variation of BER with the Increase of Number of Users.

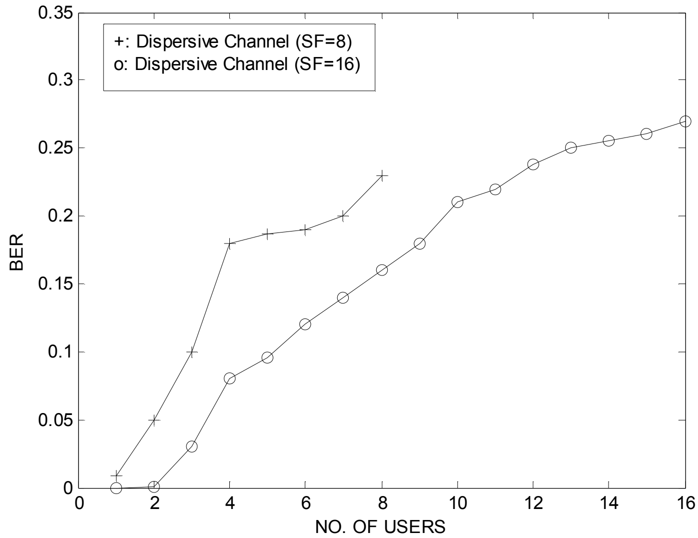

Fig. 5: Variation of BER with Respect to Number of Users for Different values of SF.

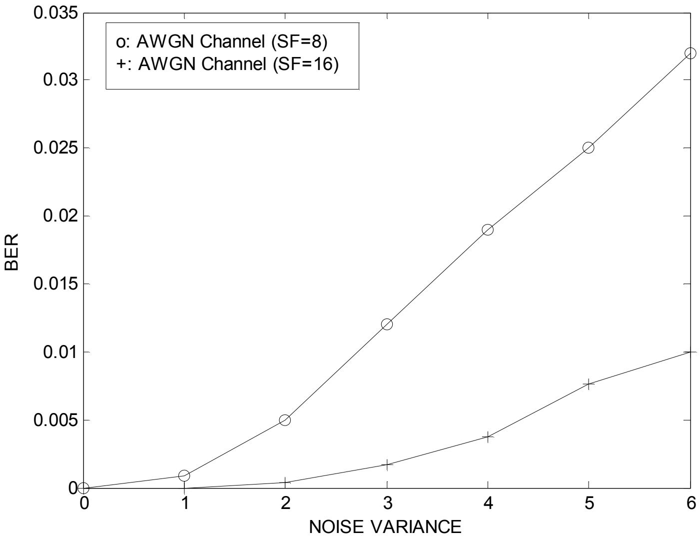

Fig. 6: Effect of Channel Noise Variance on System BER.