RESEARCH ARTICLE OPEN ACCESS

Multiple Input Analysis Of DS-CDMA Rake Receiver Simulator

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ABSTRACT
This paper would satisfy the next generation requirement of multiple input environments. Here we use a simulator which simulates the multiple input waveform signals through wireless towards the Rake Receiver which will follow through the DS-CDMA technique due to its performance. As we know the CDMA is an excellent technique to analyze the cellular systems. The simulator will give the excellent idea about the different values of the design option. Here, the backbone of this system is a wireless CDMA user link built with the help of Matlab. The effective method of system modeling is used to speed up the simulations. With the help of simulator we get the variations in the system parameters due to its different inputs. The transmitted data and the received data can be analyzed in the form of signal waveforms. We can also analyze the format of the input data and its performance with the help of simulator.

Keywords **-** CDMA (Code Division Multiple Access), DS-CDMA (Direct Sequence CDMA), FDMA (Frequency Division Multiple Access), SNR (Signal to Noise Ratio), TDMA (Time Division Multiple Access).

I. INTRODUCTION

Code Division Multiple Access (CDMA) or Code division multiplexing systems uses the spread spectrum technology and the Rake receiver concept to minimize communication errors resulting from multipath effects. In general, the number of multipath signals in the wireless channel is unknown and difficult to predict. The spread spectrum technology designs to spread the information signal over a wider bandwidth to make jamming and interception more difficult [1].

A rake receiver allows each arriving multipath signals to be individually demodulated and then combined to produce a stronger and create an accurate signal. The Rake receiver from the IS-95A CDMA system will use the three correlators and also a searcher, while the CDMA system TIA/EIA-95B limits the number of correlators in the Rake receiver to Six [5, 7].

This technique is unlike the method use in current CDMA system, which has a fix number of correlators despite the number of multipath signals in the channel.

The objective of this paper is to develop a Rake receiver through Matlab simulation that is able to increase the signal to noise ratio (SNR) performance with a minimum number of correlators.

I.1 Frequency Division Multiple Access

In Frequency Division Multiple Access (FDMA), the available bandwidth is subdivided into a number of narrower band channels. Each user from the channel is allocated a unique frequency band where transmit and receive is on. During a same call no any other user can use the same frequency band. Each user is assigned a forward link channel (from the base station to the mobile phone) and also a reverse channel (revert back to the base station), each is being a single way link. The transmitted signal of each channel is all the way continuous uses analog transmissions. The bandwidth of FDMA channel is generally low (30 kHz) as each channel only supports only one user. FDMA is used as the primary breakup of large allocated frequency bands and is used as part of most multi-channel systems [4].

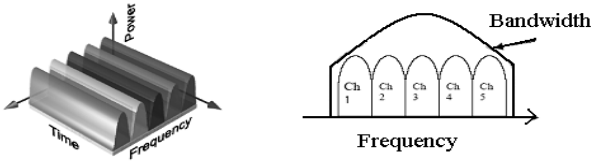

Fig 1: Frequency Band Channel

I.2 Time Division Multiple Access

Time Division Multiple Access (TDMA) divides the available spectrum into several multiple time slots, each user uses a time slot in which they can transmit or receive. Fig. 2 shows how the time slots are provided to users in a round robin fashion, with this each user being assigned one time slot per frame. TDMA system also transmit the data in a buffer and burst method, hence the transmission of each channel is non-continuous and will provide the accurate mode of signal to be propagated by considering its signal to noise ratio[4].

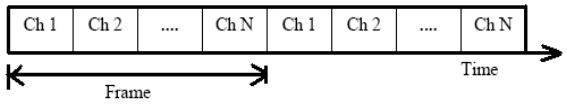

Fig 2: TDMA Scheme

I.3 Code Division Multiple Access

Code Division Multiple Access (CDMA) is a spread spectrum technique that uses neither frequency channels nor time slots. In CDMA, the narrow band message (typically digitized voice data) is multiplied by a large bandwidth signal, which is a pseudo random noise code (PN code). All users in a CDMA system use the same frequency band and transmit it very simultaneously. The transmitted signal is then recovered by correlating the received signal with the PN code used by the transmitter [1, 11].

Some useful properties that have made CDMA stronger are: Signal hiding and non-interference with existing systems, Anti-jam and interference rejection, Information security, Accurate Ranging, Multiple User Access, Multipath tolerance.

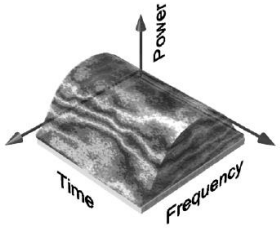

Fig 3: CDMA Scheme

The data to be transmitted (a) is spread before transmission by modulating the data using a PN code. This broadens the spectrum as shown in (b). In this example the process gain is 125 as the spread spectrum bandwidth is 125 times greater the data bandwidth. Part (c) shows the actual received signal. This may consists of the required signal with background noise and interference from any other CDMA users or radio sources.

The received signal is recovered by multiplying the signal by original spreading code. Also this process may causes the wanted effective received signal to be dispread back to the original effective transmitted data. When all the other signals are uncorrelated with the PN spreading code, they become more spread. The wanted signal in (d) is then filtered removing the wide spread interference and noise signal, it is shown in the Fig.5 below

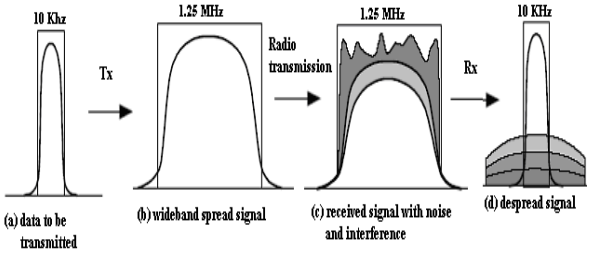

Fig. 4: Basic CDMA Generation.

CDMA is achieved by modulating the data signal by a pseudo random noise sequence (PN code), which has a chip rate higher than the bit rate of any data. The PN code sequence of a signal is a sequence of ones and zeros (also called chips), which is alternate in a random fashion. The data is modulated with modular-2 adding data with the PN coding sequence. This can be done by multiplying all the other signals, provided that the data and PN coding is represented by 1 and -1 instead of 1 and 0. Fig.5 shows a basic CDMA transmitter [1, 11].

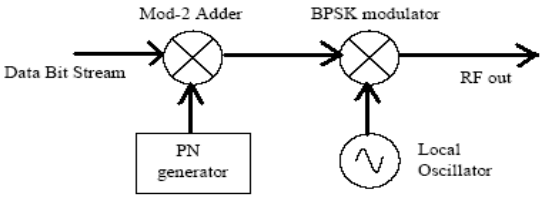

Fig.5: Simple Direct Sequence Modulator

II. RAKE RECEIVER

Rake receiver architecture allows an optimal combining of energy received over path with different signal waveforms. It avoids the wave cancellation (fade) If delayed path arrive with phase differences and weighs signals coming in with different Signal to noise ratios. It also reduces the bit error rate and bit transmission rate. The basic components of the Rake Receivers are as mentioned in Fig. 6[8].

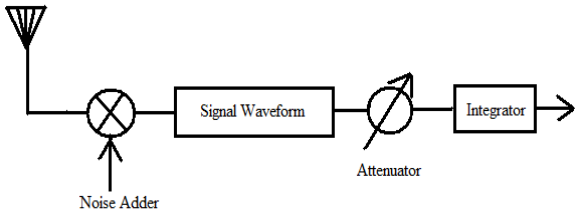

Fig. 6: Rake Receiver Process Components

II.1 Major Operation

There are three major operations carried out in the RAKE Receiver:

(1) Capturing the delayed versions of the receiver signals.
(2) IQ demodulation using the references PN sequences, which are used in IQ-modulation in

the transmitter and

(3) Assigning weights to the correlate outputs and performing maximal combining to retrieve a final signal.

II.2 Coefficient

Each correlator of the RAKE receiver is being represented by three coefficients:

(1) Time delay.

(2) Phase shift.

(3) Amplitude gain/attenuation

In the matched filter receiver, the signal is being correlated with a locally generated signal waveform. However, the signal is distorted by the channel, the receiver should be correlate the incoming signal by an expected received signal, rather than by transmitted waveform. Hence the receiver should estimate the delay profile of the channel, and adapt its locally generated copy according to this estimate signal [4, 8].

In the multipath channel, delayed reflections, noise, signal waveforms interfere with the direct signal. Whereas a DS-CDMA signals suffering from multipath dispersion can detect a Rake receiver. This receiver extremely combines signals received by multiple paths.

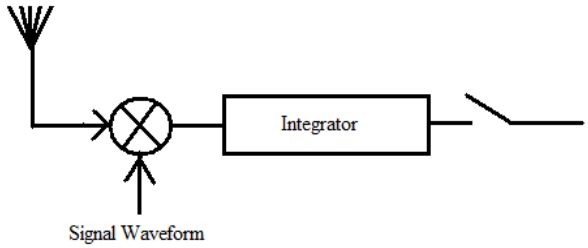

Fig. 7: Matched Filter Receiver for AWGN Channel [8]

III. MULTIPATH FADING CHANNEL

The abbreviation "fading" describes the small-scale variation of a mobile radio signal. As each transmitting signal is represented by a number of multi path and each having different propagation delays, the channel impulse response is different for each multi path. Therefore, not only the channel response is time varying, the channel response is also functional dependent on the propagation delay. Hence, the channel impulse response should actually be summarized as h (t, t), which't' is the specific time instance, and 't' is the multi path delay for a fixed value of 't'. As a result, the received signal in a multi path channel consists of number of attenuated signals, time delayed periods, and phase shifted versions of the original signal, and the base band impulse response of a multi path channel.

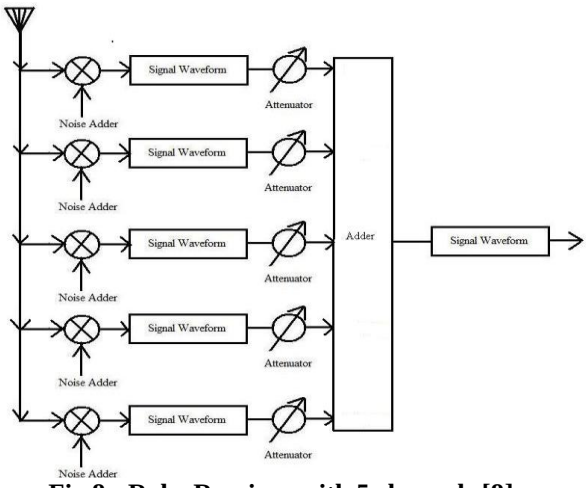

Fig.8: Rake Receiver with 5 channels [8]

The communication channel is the medium which the transmitting radio signal goes through in order to reach the receiver. The channel can be modelled as a linear filter with a time varying channel impulse response. A channel impulse response describes the amplitude and phase effects that the channel will impose on the transmitting radio signal, as it transmits through the medium.IS-95 CDMA Communication channels are often modelled as a multi path fading channel, as it is the best Modelling for a mobile communication channel.

IV. SYSTEM MODEL ANALYSIS

Similar to garden rake, the rake receiver gathers the energy received over all the different delayed propagation paths. As per the maximum ratio combining principle, the SNR at the output is nothing but the sum of the SNRs in the separate branches, provided that,

1. We assume that only AWGN is present (no interference)
2. Codes with a time offset are truly orthogonal.

Signals are arriving with the same excess propagation delay as the time offset in the receiver are retrieved approximately, because

$$\sum_{n=1}^{N} c_1^2(nT_c + t_d) = \sum_{n=1}^{N} c_1^2(nT_c) = N \qquad (1)$$

This reception concept is repeated for every delayed path that is received with accurate power. According to single correlator branch, multipath self-interference from any other paths is attenuated here, because one can choose codes such that [1, 11].

$$\sum_{n=1}^{N} c_1(nT_c)\, c_1(nT_c + t_d) \cong 0 \qquad (2)$$

V. MULTIPATH RECEPTION

Experiments with mobile communication

were done at VHF frequencies, around 50 MHz, already in the past 1920s. Results of these tests reflected a very hostile propagation environment, particularly in urban centres. The signal quality varied from "excellent" to "no signal". Moving the vehicle over a few meters resulted in dramatic changes of the received field strength [2].

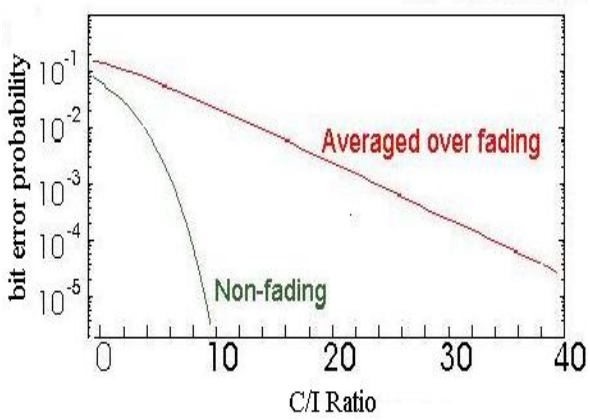

Fig. 9: Bit Error in Multipath Fading [2]

VI. PURPOSE OF SIMULATOR

The objective of this research is to simulate and evaluate the performance of deferent parameter and RAKE receiver performance for the CDMA. It is well known that CDMA simulator and the simulation software developed for this research implements RAKE and without RAKE methods in combination with CDMA standard.

This work will provide crucial information leading to the implementation of CDMA simulator in a real-world system. RAKE to multiple stages of interference cancellation. RAKE was used in this work along with receivers that used the information in the channel. For both rake and without rake, we compare them in multipath environment. It will be shown that the use of number of bit error in received data by the RAKE receiver is less than the received data of without RAKE receiver advantages of RAKE receivers [3, 10].

VII. SIMULATION ANALYSIS

There are six signal waveforms we have considered here to transmit towards the Rake receiver, the waveform signal which is going to combine with each other have mentioned in Fig.10 to Fig.15 respectively.

We can easily understand what kind of waveform signals we are transmitting to get mixed.

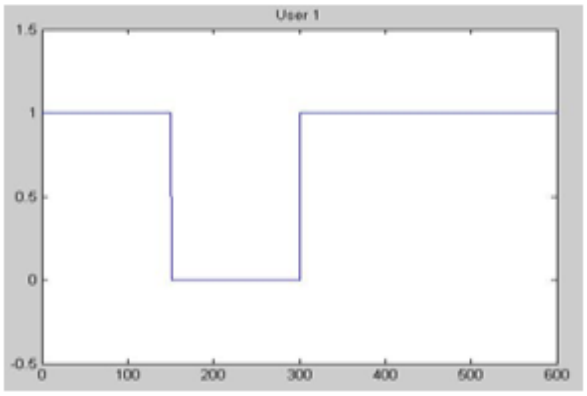

Fig.10: User 1 input waveform signal

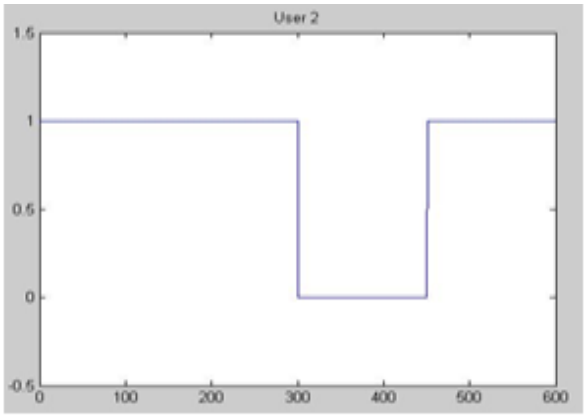

Fig.11: User 2 input waveform signal

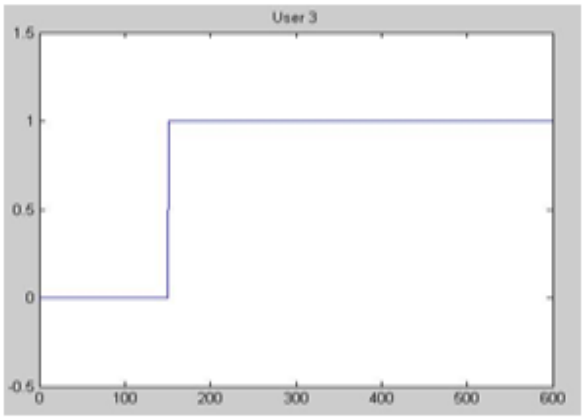

Fig.12: User 3 input waveform signal

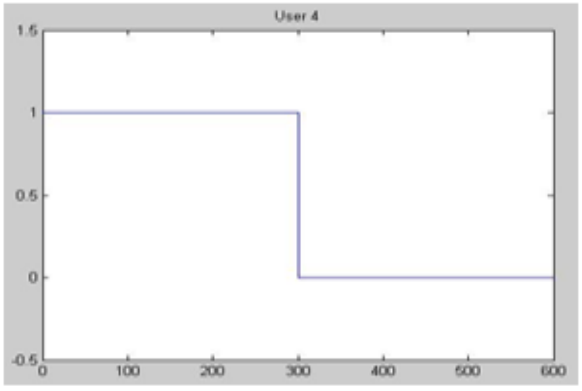

Fig.13: User 4 input waveform signal

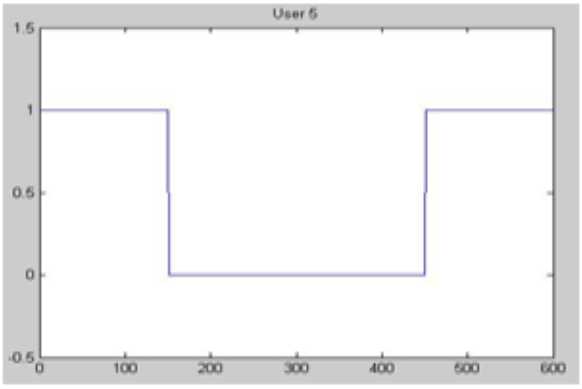

Fig.14: User 5 input waveform signal

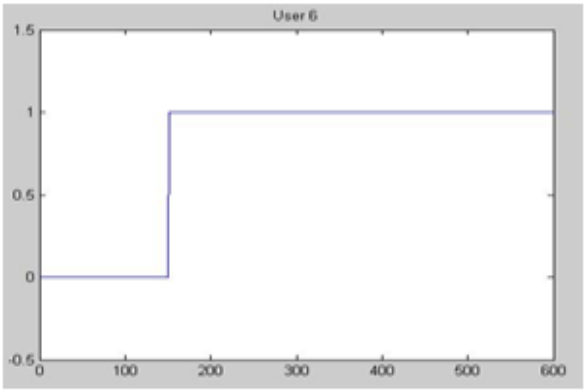

Fig.15: User 6 input waveform signal

VIII. FUTURE SCOPE

We have developed a simulator made in our paper work, we have shown in this paper that how rake receiver in used for CDMA to decrease bit error due to multiple input interferences and also it can simulate with the different attenuation factor. It can simulate a CDMA encoding and decoding process, here the data is assumed to be travelled through multiple path and the effect of multiple path and CDMA is assumed to generate the multipath effect and the data is pass through the different path and assumed at receiver end just before the decoder to avoid the multipath effect RAKE receiver is used the RAKE receiver concept is introduced in the decoding process.

In future, we can add more factorsto implement this system to get effective received signal.

IX. CONCLUSION

The system which can be efficiently reduce the bit error rate is introduced in this paper i.e. DS-CDMA technique. It is also putting the impact on the wireless system that how we increase or decrease the attenuation factor and hoe it affect on the wireless system while applying the multiple inputs.

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