Performance Evaluation of Asynchronous SDMA-CDMA for Mobile Cellular System

Asst. prof. Dr. Qaidar M.Quboa * Lecturer Dr. Abdulsattar M. A.** Reem B. Saadallah*

Abstract

In the last few years, the demand for mobile communication services has increased tremendously. However, there is no proportionate increase in the spectrum allocated. As a result, there is an urgent need for new techniques to improve system spectral efficiency, therefore maximizing the capacity of cellular system. SDMA (Space Division Multiple Access) integrated with CDMA (Code Division Multiple Access), resulting a system which combines between the robustness against Multiple Access Interference (MAI) of the SDMA and the multiuser capability of CDMA which is reflected on the performance of the SDMA-CDMA system. In this paper the BER performance of asynchronous (Uplink) CDMA mobile cellular system was simulated, taking into account Rayleigh fading channel, convolutional encoder, Viterbi decoder, and Rake Receiver. Simulation results was agreed with theoretical results for different, system parameters such as number of users, spreading factors, number of multipath, Rake fingers, adjacent interfering cells, , and coding ratio. When antenna directivity was introduced, results shows that the SDMA-CDMA system has a significant performance improvement over that of a conventional CDMA system.

Keywords: SDMA-CDMA , Rake Receiver, convolutional encoder, Viterbi decoder

* University of Mosul
** Alhdba University College

1. Introduction

Code division multiple access (CDMA) is a “spread spectrum” technology, which spreads the information over a much greater bandwidth than the original signal. This is achieved by multiplying the signal by a very large bandwidth signal called the spreading signal. Each user has its own pseudorandom code word which is approximately orthogonal to all other code words [1].

The capacity of CDMA system, which is defined as the maximum number of users that can be provided in a fixed frequency band is interference limited.This means that as the number of users in the CDMA system increase, the noise floor raises in a linear manner which decreases the system performance [2]. SDMA is recognized as one of the most useful techniques for enhancing the performance and increase capacity (number of user per cell) of a cellular systems. Since the capacity of CDMA system is essentially limited by multiple access interference (MAI), SDMA techniques allows different users to share the same available resources at the same time and are distinguished only in the spatial dimension. Inparticular, the radiation pattern of the base station, both in transmission and receptions is adapted to each different users so as to obtain, the highest gain in the direction of the mobile user [3].

In this paper MATLAB simulation was presented for asynchronous reverse link of Code Division Multiple Access (CDMA), to evaluate system performance represented by the BER metrics, and the capacity presented by number of users (k) over a frequency selective multipath Rayleigh fading channel considering Convolution encoder with Code rate (r) 1/4 at the transmitter and Rake receiver with Viterbi Decoder at the receiver. SDMA-CDMA System technique was evaluated with the use of a directional antenna at the mobile base station.

2. Adaptive antenna

Figure (1) shows three possible base station antenna configurations. The use of omnidirectional receiver antenna leads to a waste of transmitting power and to increased interference levels because most of the transmitted power is radiated in other directions than the one where the intended user is. As a result only a small fraction of the total transmitted power is usefully captured by the desired user and the rest of it acting as MAI in the cell. The sectored antenna will divide the received noise in to a smaller value and will increase the number of users in CDMA system [4].

Adaptive antenna provides a spot beam for each user and base station tracks each user in the cell as it moves. Assume that beam pattern F(θ) is formed such that the pattern has maximum gain in the direction of desired user and nulls in the direction of interferers, resulting in a directive antenna since the antenna directivity(D) is given by max F(θ). This technique will maximize the SNR because as the antenna beam pattern is made narrower, the (D) increases respectively and the received interference decreases proportionally allowing higher data rates, and a reduction of the transmission power in both uplink and downlink [5].

Figure (1) - Base Station Antenna Configuration

3.The mathematical model of asynchronous (reverse link) SDMA-CDMA

The asynchronous or reverse link(from mobile stets to base station)SDMA-CDMA system model is shown in figure (2) .

Considering k active users transmitting signals in asynchronous SDMA-CDMA system, each of them tansmiting a signal which is described in the following equation below [6].

$$S_k(t-\tau_k) = \sqrt{2P_k}b_k(t-\tau_k)c_k(t-\tau_k)\cos(\omega_c t+\theta_k) \qquad (1)$$

Where $b_k(\cdot)$ is binary data sequence, $c_k(\cdot)$ is a spreading sequence, P_k is the power of the transmitted signal, ω_c is the carrier angular frequency, τ_k is the time delay of user k relative to some reference $user_0$ that accounts for the lack of synchronism between the transmitters, and θ_k is the carrier phase angle of user k relative to a reference $user_0$. since τ_k and θ_k are relative terms, we can define τ_k=0 and θ_k=0

The channel $h_k(\cdot)$ is assumed multipath Rayleigh frequency selective fading channel. The delay difference between any two different paths are larger than the chip duration (T_c)of the spreading sequence. The complex low pass equivalent impulse response of the channel is given by:

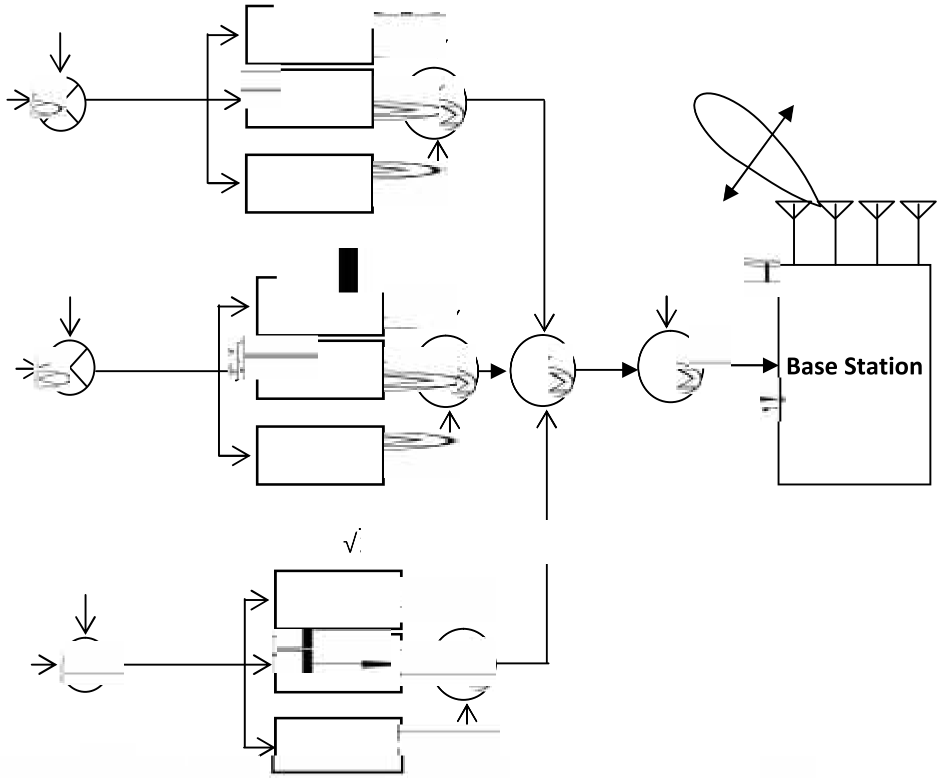


Figure (2) - AsynchronousSDMA-CDMA link Model

$$h_k(t) = \sum_{l_k=1}^{L_k} \alpha_{k,l_k} e^{j\Phi_{l,l_k}} \delta(t - \tau_{k,l_k}) \quad (2)$$

Where Φ_{kl_k} is the phase of the multipath component, τ_{kl_k} is the path delay, L_k is the number of multipath components and α_{kl_k} is magnitude of the l^{th} multipath with Rayleigh distribution.

A correlated receiver is typically used to filter the desired user from all other user which share the same channel, Therefore the received signal at the input of the receiver is given by:

$$r(t) = h_l(t) \times S_k(t) + n(t) \quad (3)$$

$$r(t) = \sum_{k=0}^{K-1} \sum_{l_k=1}^{L_K} \sqrt{2P_k}\, \alpha_{k,l_k} b_k(t - \tau_{k,l_k}) \times c_k(t)\cos(t - \tau_{k,l_k})\cos(\omega_c t + \Phi_{k,l_k}) + n(t) \quad (4)$$

Where n(t) is Additive White Gaussian Noise (AWGN) with a two sided power spectral density of $N_0/2$ and N_0 is the noise power spectral density measured in watts/hertz (joules)[7].

SDMA technique is applied at the base station of the cellular mobile systemusing adaptive arrayantenna to form directed beam towards the desired user ($user_0$), thus will minimize the interference from the other users in the same cell and the users from the adjacent cells.

4. Rake receiver

Due to the signal propagation characteristics of the wireless communication channel, the receiver may receive one direct line-of-sight (LOS) wave and many multiple versions of the transmitted signal at a separatedof arrival times. If these multipath signals are delayed in time by more than one chip interval, Rake receiver is required. Rake receiver attempts to collect the time shifted versions of the original signal by providing a separate correlation receiver for each of the multipath signals [8]. The output of The M correlators are then weighted by α_1, α_2 and α_m to provide a better estimate of the transmitted signal.Demodulation and bit decision are then based on the weighted outputs of the correlators. Rake receiver is shown in Figure (3) which achieves a significant improvement in the SNR at the receiver end and thus improve communication reliability and performance [7].

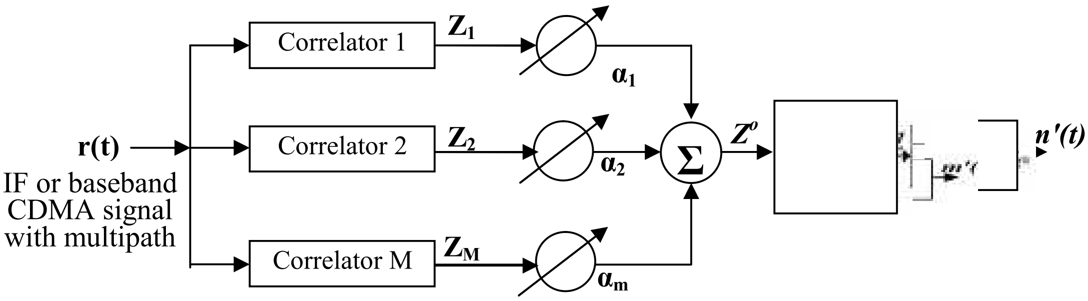


Figure (3) - Block diagram of Rake Receiver.

5. Design of convolutional encoder

A convolutional code is a type of error-correcting code.It introduces redundant bits into the data stream through the use of linear shift registers to permit reliable communication of an information sequence over a channel that adds noise, introduces bit errors, or otherwise distorts the transmitted signal[9].

The encoding is done by passing the information sequence (k-bit sequence) through a linear finite state shift register to be transmitted into an n-bit sequence, where k/n is the code rate(r) and (n ≥ k).

The number of shifts required for a message bits to enter the shift register and finally come out is called the constraint length of the code (CL) [10]. In this paper Constraint Length CL= 3 is used with code rate r=1/4 as shown is Figure (4).

The Generator Polynomial shows the hardware connection of the shift register taps to the modulo-2 adders, In this paper the Generator Polynomial (G) for the encoder in Figure (4) is $[7\ 7\ 5\ 5]_8$ where G1= $[111]_2$, G2= $[111]_2$, G3= $[101]_2$, G4= $[101]_2$ and v1, v2, v3, v4 are the corresponding output terminals.

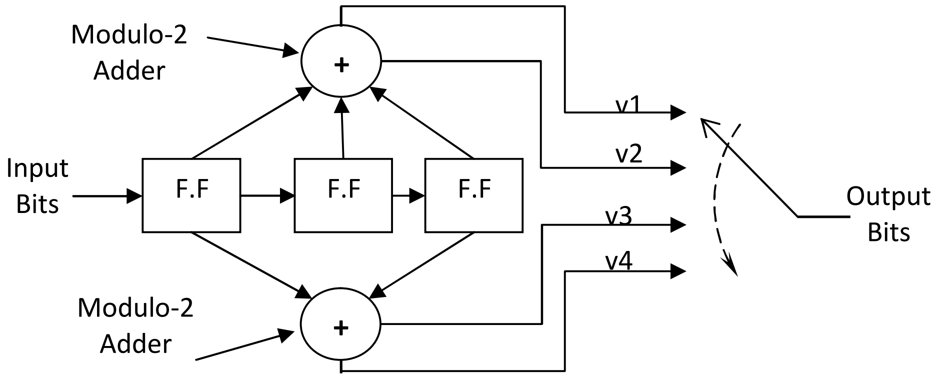


Figure (4) - Block Diagram of Convolutional Encoder with CL= 3 and r = 1/4

5.1 State Diagram

Since the output of the encoder is determined by the input and the current state of the encoder, a state diagram (signal flow graph) can be used to represent the encoding process[11].

The table below gives the present state (PS) and the next state (NS) of convolutional encoder where number of states = $2^{(CL-1)}$.

Table (1) The present state (PS) and the next state (NS) of the convolutional encoder

State Diagram Table					
Present State (PS)		Next State (NS)		Output (in Octal)	
		i/p = 0	i/p = 1	i/p = 0	i/p = 1
0	S(a)	S(a)	S(c)	0	17
1	S(b)	S(a)	S(c)	17	0
2	S(c)	S(b)	S(d)	14	3
3	S(d)	S(b)	S(d)	3	14

State diagram can be concluded from table(1) as shown in Figure(5).
Figure (5-b) is deduced from Figure (5-a) where the dotted lines indicate that the input bit is 1 and solid lines indicate that the input bit is 0.The exponent of D_c on a branch describes the number of 1's in the sequence of encoder output corresponding to that branch. The exponent of J is always equal to 1 and the exponent of N denotes the input (i.e. for input 0, exponent of N is 0 and for input 1, it is equal to1).

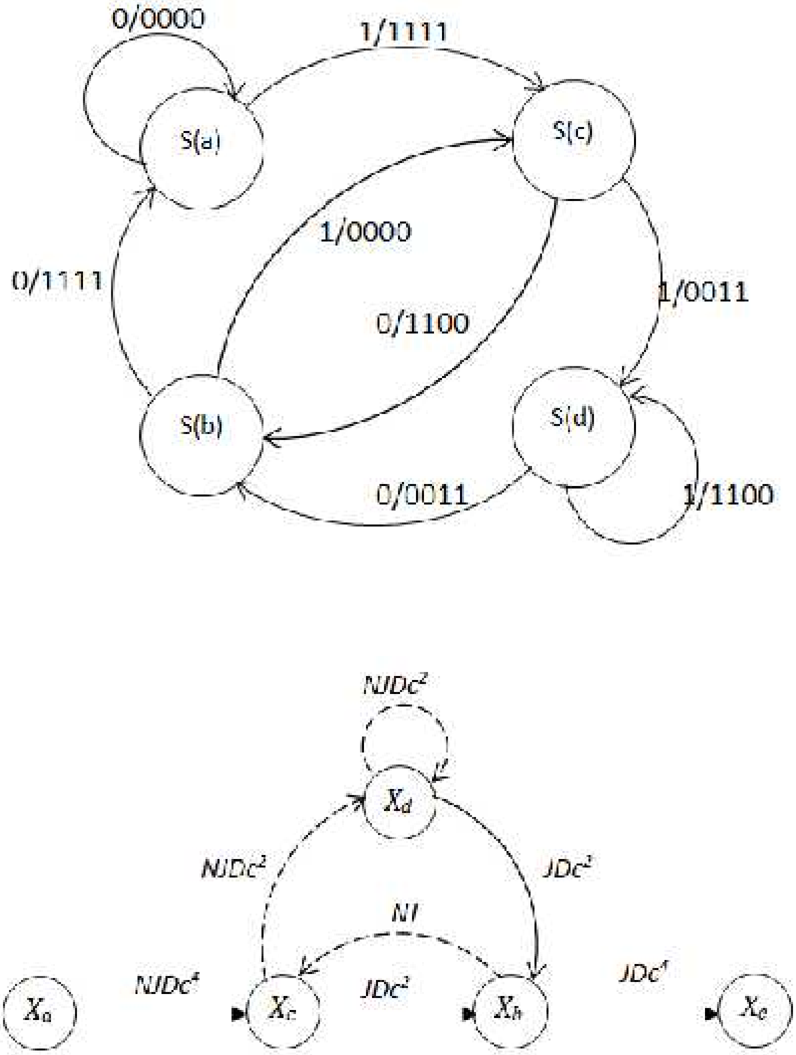


Figure (5) - State Diagrams for convolutional encoder

5.2 Transfer function of convolutional code

Nodal equations are obtained from the state diagram shown in Figure (5-b) and the results are:

$\mathbf{X_c = NJD_c^4X_a + NJ\ X_b}$ **(5a)**
$\mathbf{X_b = JD_c^2X_c + JD_c^2X_d}$ **(5b)**
$\mathbf{X_d = NJD_c^2X_c + NJD_c^2X_d}$ **(5)**
$\mathbf{X_e = JD_c^4X_b}$ **(5d)**

The transfer function (TF) is defined as

$$\mathbf{TF(D_c;J;N) = \frac{O/P}{I/P} = X_e/X_a} \quad \mathbf{(6)}$$

By solving the state equations and set J = 1, the transfer function(TF) is given by:

$$TF(D_c;N) = \frac{ND_c^{10}}{(1-2ND_c^{2})} \qquad (7)$$

The transfer function (TF) in equation (7) can be represented in power series as the following:

$$TF(D_c;N) = N * Dc^{10} + 2N^2 * Dc^{12} + 4N^3 * Dc^{14} + \cdots \qquad (8)$$

6. Viterbi decoder

The most famous decoder for convolutional code is Viterbi decoder [12]. To explain how Viterbi decodes and correct errors we assume the user information is [1111] this information is then encoded through convolutional encoder shown in Figure (4) and the output bits are [1111 0011 1100 1100].Transmitting the information through the noisy channel introduces errors and therefore we assume the received bits are [1101 1011 1100 0100]. The Viterbi decoder uses Viterbi algorithm which computes the metric for each path in the trellis diagram that is drawn from the state diagram which is shown in Figure (5).

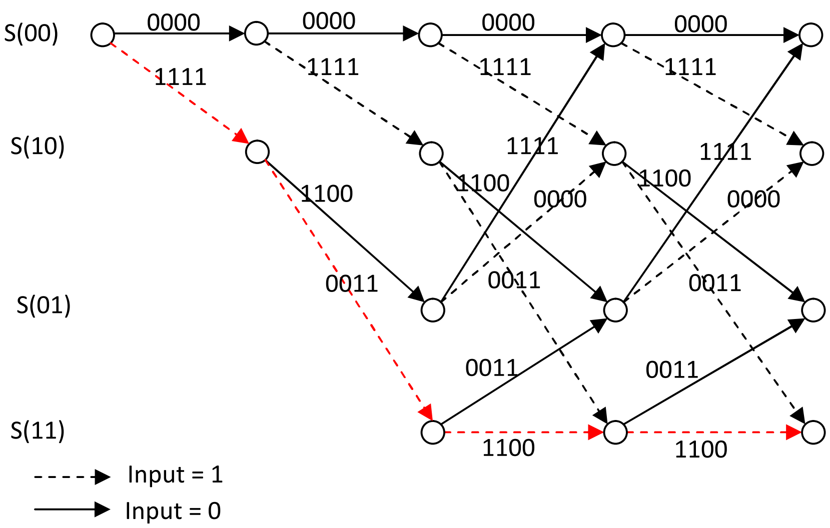


Figure (6) - Trellis diagram

The most common metric used is Hamming distance metric which is the difference between thereceived bits and the bits on the trellis as shown in Figure (6).

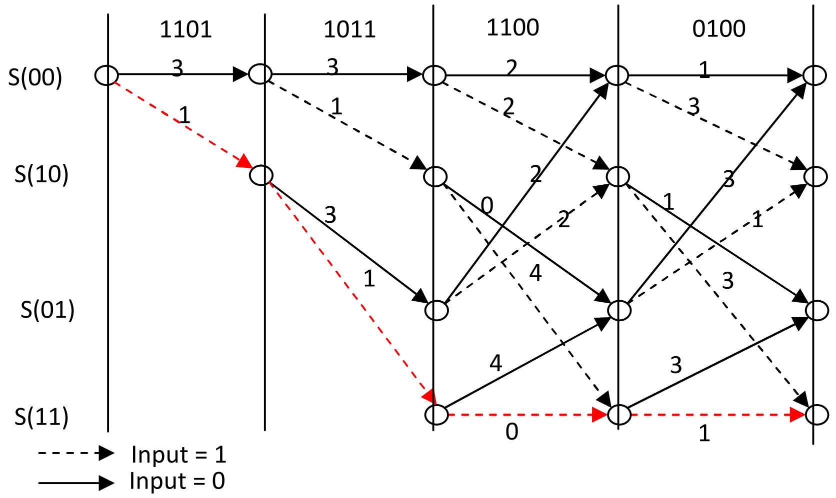


Figure (7) -Trellis metric

The Figure (7) shows that the best path is the path with minimum sum of Hamming weights [1+1+0+1=3] and by noticing this path on the trellis in Figure (6), we get the sequence [1111 0011 1100 1100] which are the transmitted bits.Therefore the Viterbi decoder not only decode the received bits but also correct the errors caused by the noise in the channel[11].

7. BER evaluation

In this section, we consider the standard Gaussian approximation (SGA) of the noise and interference on the receiver output to evaluate the bit error rate (BER) performance for an asynchronous CDMA system and SDMA system with perfect power control over a frequency selective multipath Rayleigh fading channel with BPSK, adjacent cells interference, Rake Receiver, convolutional code and Viterbi decoder.

Using Rake Receiver with Maximal Ratio Combiner in the system having M number of fingers and convolutional encoder considering perfect channel estimation then the BEP (Bit Error Probabilty) for the SDMA -CDMA system is [13]:

$$BEP_c = \left(\frac{1-\mu_1}{2}\right)^M \sum_{j=0}^{M-1} \binom{M-1+j}{j} \left(\frac{1+\mu_1}{2}\right)^j \qquad (9)$$

Where

$$\mu_1 = \sqrt{\frac{1}{1+\frac{N_0}{2rE_b}+\frac{2}{3DN_c}\left[\left(1+\frac{M_c}{5}\right)LK-1\right]}} \qquad (10)$$

and BER is given by[9]:

$$BER \le \frac{d}{dN} TF(D_c;N)\Big|_{N=1,\, D_c=2\sqrt{BEP_c(1-BEP_c)}} \qquad (11)$$

8. Simulation

In order to evaluate system performance, MATLAB program is used to offer near scenario of asynchronous CDMA system and the block diagram in Figure (8) gives simulation strategy that have been used. The parameters used in the simulation are in the Table (2).

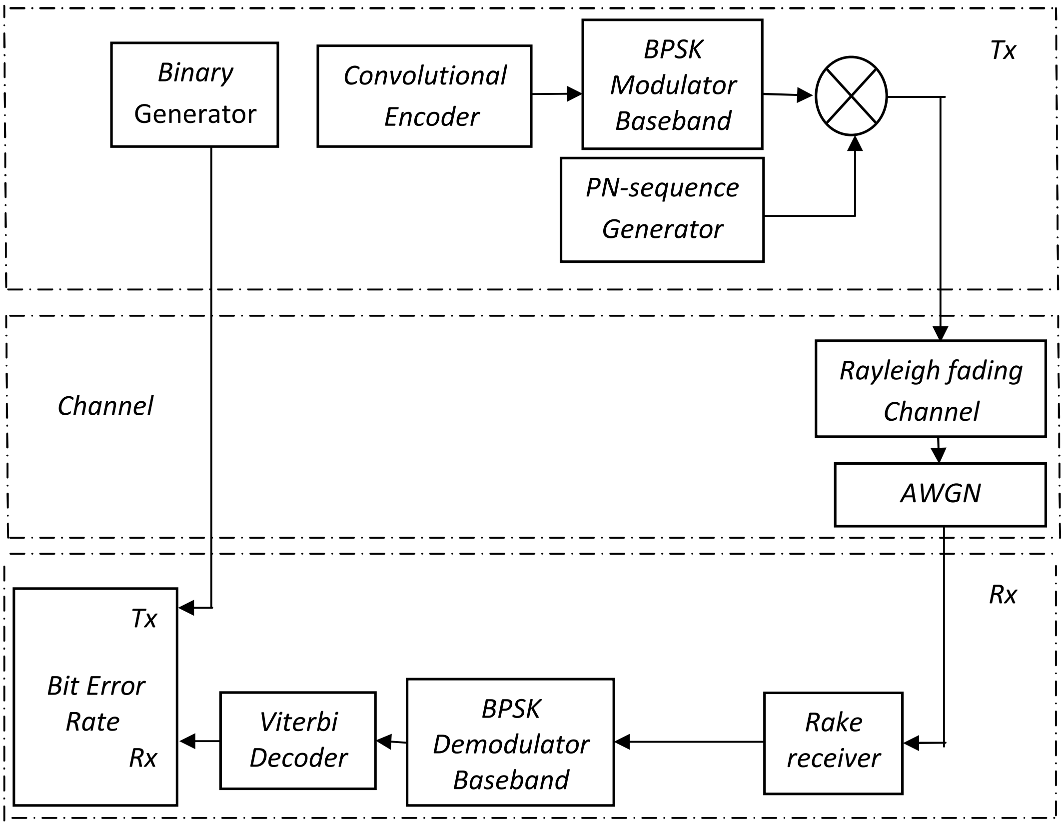


Figure (8) - CDMA simulation strategy

Table (2) Simulation Parameters

Simulation parameters	value
Bit time (Tb)	1msec
Modulation type	BPSK
Carrier frequency (Fc)	1kHz
Spreading factor (Nc)	32
Number of users (K)	10
Chip time (Tc)	31.25 µsec
SNR	5 dB
Code rate (r)	1/4
Multipath	4
Rake fingers (M)	4
Adjacent interfering cells(Mc)	1
Constraint length (CL)	3

8.1 Simulation and theoretical results

8.1.1 effect of Rake receiver

From Figure (9) at BER=10^{-1}, the CDMA system without Rake receiver can support 5 users only while it can support 40 users with Rake receiverwhen number of fingers M=4.From Figure (10) at Eb/No=5 dB the BER≈0.17 without Rake receiver while BER≈ 1.5×10^{-2} using Rake receiver.This means that adding Rake receiver to the system will improve system capacity and performance.

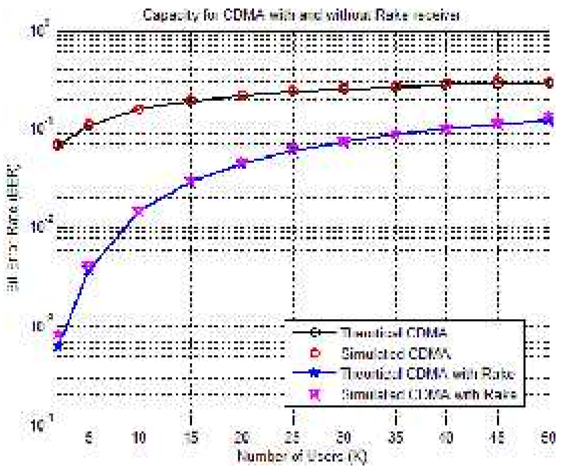


Figure (11) - Capacity with without Rake Receiver

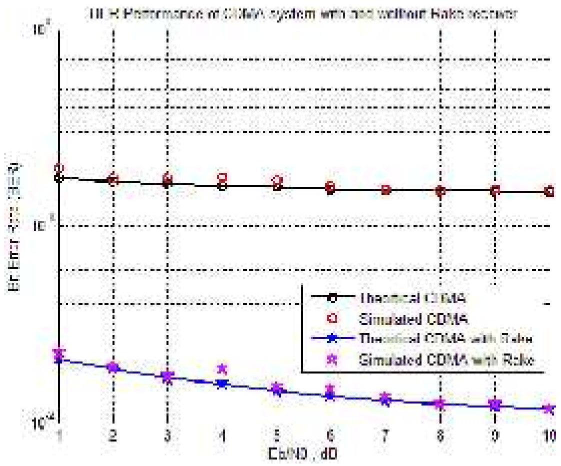


Figure (10) - BER performance with and without Rake Receiver

8.1.2 effect of finger (M)

From Figure (11) at BER= 10^{-1},increasing the Rake receiver fingers (M) from 2, 3 to 4 increases the capacity of the CDMA system from 15, 30 to 45 usersrespectively.In Figure (12) atEb/No=4 dB ,varying M from 2,3, to 4 BER will decrease from BER ≈ 7×10^{-2}, ≈ $3.1 \times 10^{-2}$to ≈ 1.6×10^{-2}respectively.

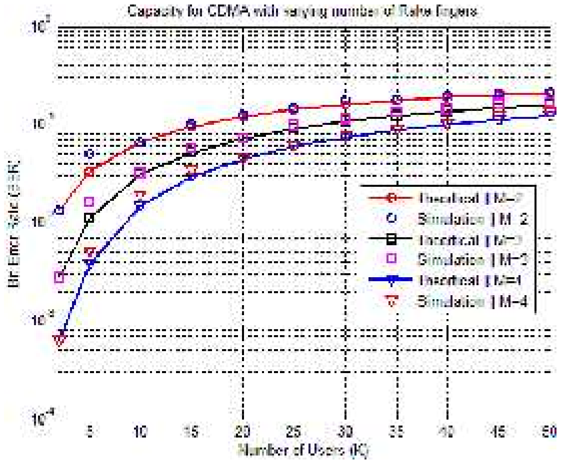


Figure (11) - Capacity with varying number of Rake fingers (M)

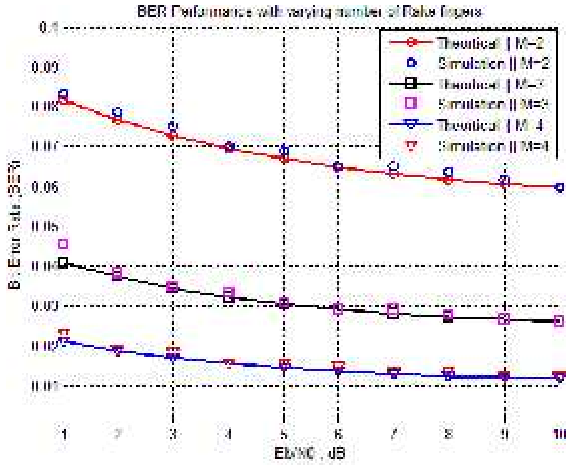
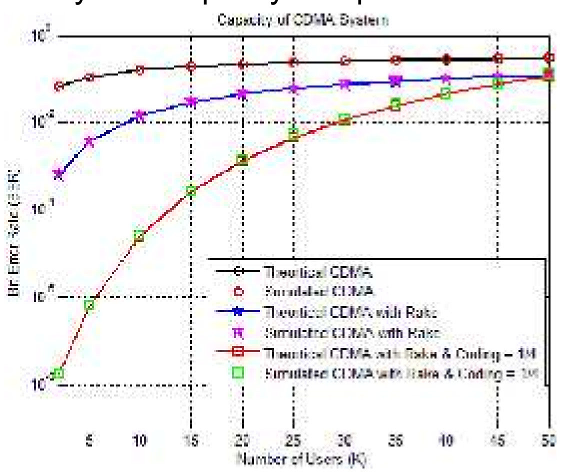


Figure (12) - BER performance with varying number of Rake fingers (M)

8.1.3 effect of channel coding

Figure (13) and Figure (14) show the effect of adding channel coding to the system. From Figure (13) at BER≈ 10^{-2}, the CDMA system with Rake receiver can support 10 users only while it can support 30 users using Rake receiver with code rate r=1/4 and Viterbi Decoder.From Figure (14) at Eb/No=6 dB, the BER≈10^{-2} using Rake receiver only while BER≈10^{-5} using Rake receiver with coding r=1/4 and Viterbi decoder. This means that using Viterbi decoder at the receiver will improve strongly the system capacity and performance.



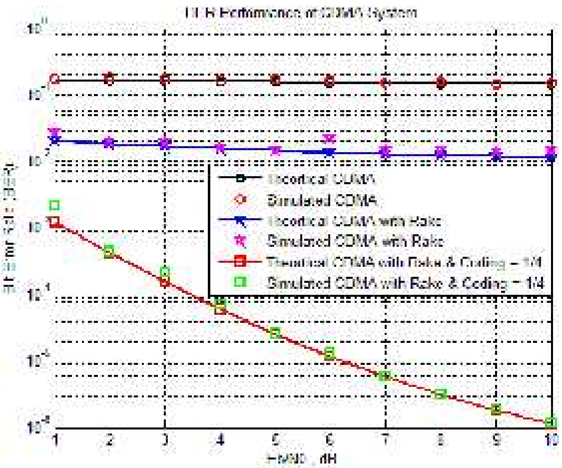


Figure (13) - Capacity with and without rake receiver and coding

Figure (14) - BER performance with and without rake receiver and coding

8.1.4 effect of the code rate (r)

Figure (15) and Figure (16) show how increasing the code rate (r) of convolutional encoder can affect the capacity and the performance of CDMA system. At BER= 10^{-2} in Figure (15), the system capacity increases from 11, 18 to 30 users with decreasing the code rate from 1/2, 1/3 to 1/4 and from Figure (16) at Eb/No=6dB, system performance increases from BER ≈ 4×10^{-3}, ≈ 2×10^{-4} to ≈ 10^{-5} for the same r increments.

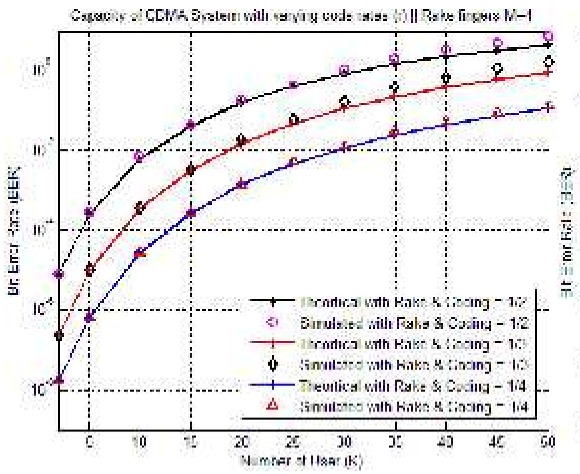


Figure (15) - Capacity with varying code rate (r)

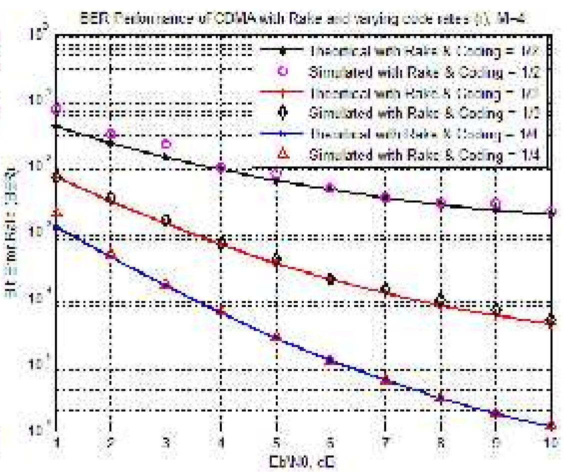


Figure (16) - BER performance with varying code rate (r)

8.1.5 effect of the spreading factor (N_c)

From Figure (17) at BER=10^{-2} increasing the spreading factor (N_c) from 4, 8, 16 to 32 increases system capacity from 4, 8, 15 to 30 users respectively. In Figure (18) at Eb/No=5 dB, system performance increases from BER ≈5×10^{-1}, ≈8×10^{-2}, ≈10^{-3} to ≈2×10^{-5} respectively for the same Nc increments.

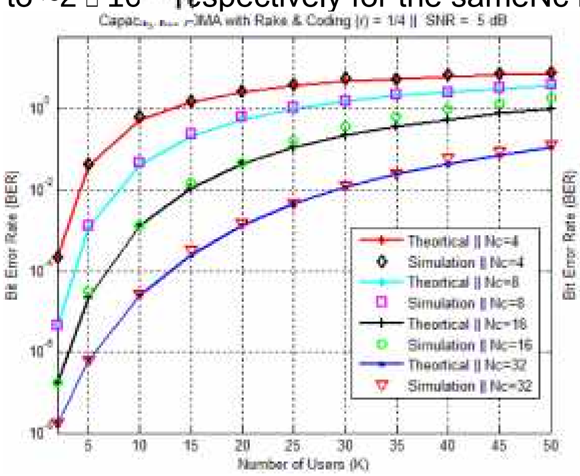


Figure (17) - Capacity as a function of Spreading Factor (N_c)

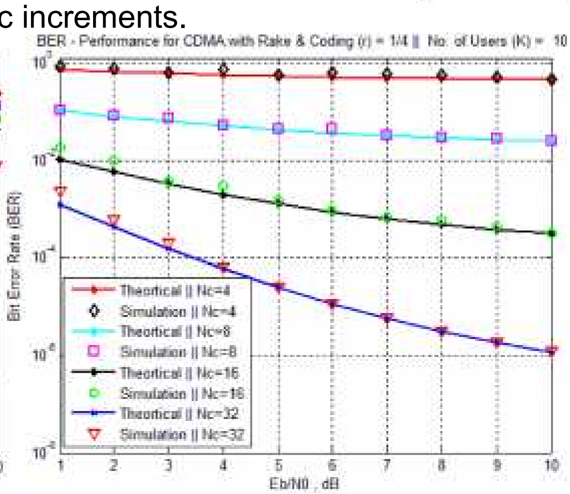


Figure (18) - BER performance as a function of Spreading Factor (N_c)

8.1.6 effect of multipath factor (L)

From Figure (19) at BER=10^{-6}, increasing the multipath factor (L) from 1, 2, 3 to 4 decreases system capacity from 22, 11, 8 to 6 users respectively. In Figure (20) at Eb/No=8dB, system performance will degrade from BER $\approx 10^{-10}$, $\approx 10^{-8}$, $\approx 6 \times 10^{-7}$ to $\approx 3 \times 10^{-6}$ respectively for the same L increments.

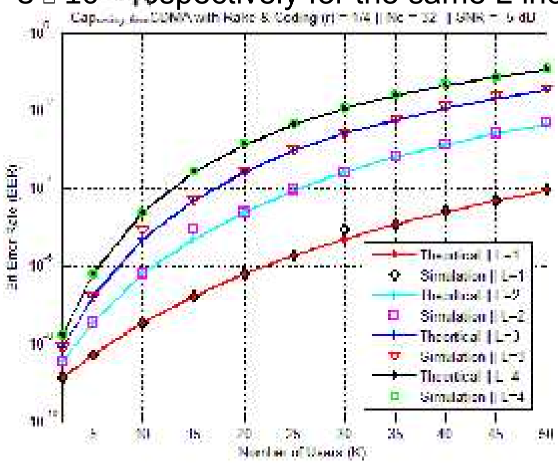


Figure (19) - Capacity as a function of multipath (L)

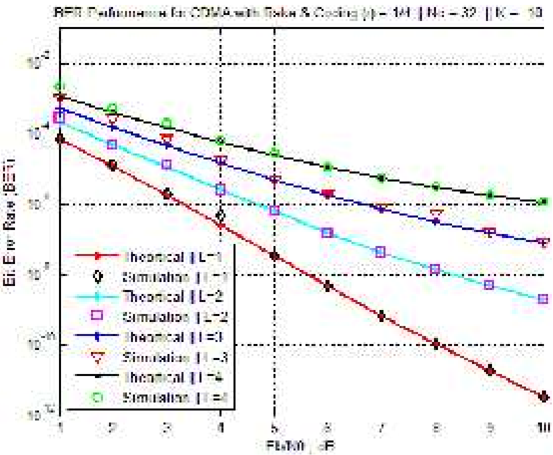


Figure (20) - BER performance as a function of multipath (L)

8.1.7 effect of number of users (K)

Figure (21) at Eb/No= 6dB, increasing number of users (K) from 10, 20, 25 to 30 degrades the system performance from BER $\approx 10^{-5}$, $\approx 10^{-3}$, $\approx 3 \times 10^{-3}$ to $\approx 10^{-2}$ respectively.

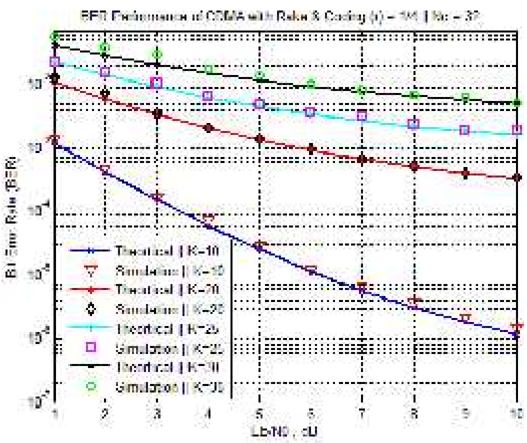


Figure (21) - BER performance as a function number of (K) users

8.1.8 effect of using SDMA-CDMA

In Figure (22) at BER=10^{-6} , with Rake receiver and coding, CDMA system can support 6 users only while SDMA-CDMA system can support 35 users. This means SDMA technique can improve the CDMA system capacity using directional antenna at the system base station.In Figure (23) and at Eb/No=3dB, the BER decreases from ≈ 10^{-4} to ≈ 10^{-6}, using SDMA.

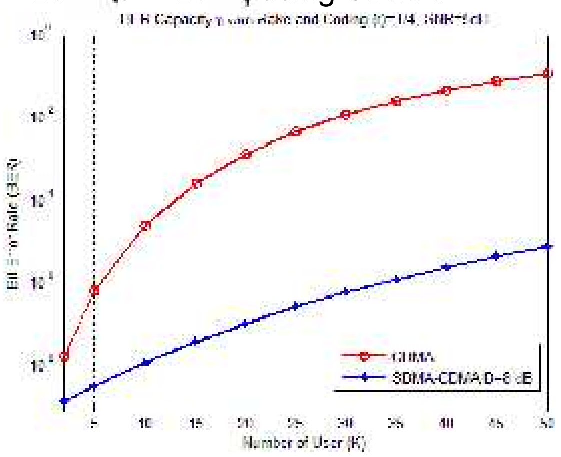


Figure (22) - Comparing capacity between CDMA and SDMA

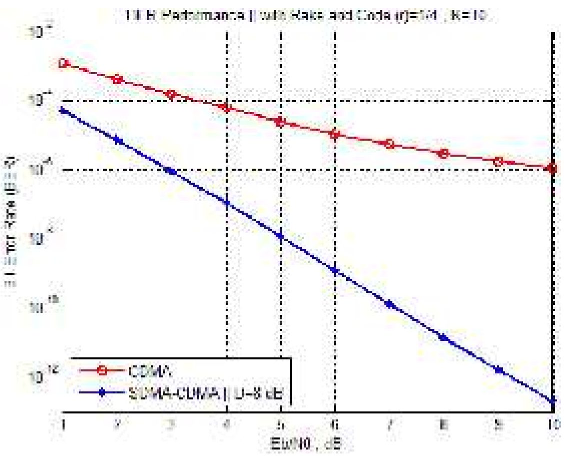


Figure (23) - Comparing BER performance between CDMA and SDMA

From Figure (24) at BER= 10^{-6}, increasing thedirectivity of the base stationantenna from 3, 5 to 8 dB leads to increase in system capacity from 11, 17 to 34 users respectively.From Figure (25) and at Eb/No=5 dB the system performance increases from BER≈ 10^{-6}, ≈ 10^{-7} to ≈ 10^{-8} respectively for the same directivity increments. This shows that introducing a directive smart antenna(SDMA technique) at the base station has a significant effects on system performance.

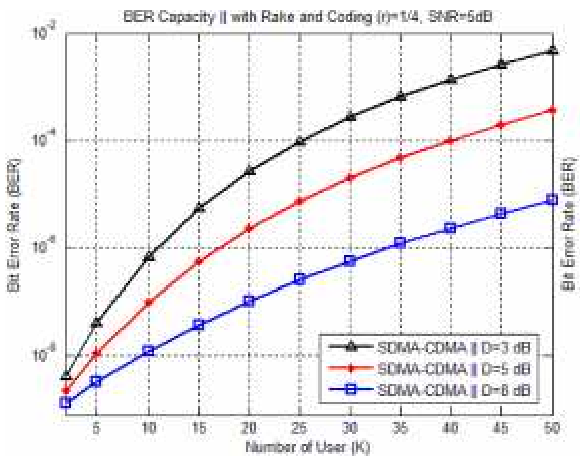


Figure (24) - Capacity as a function of Directivity (D)

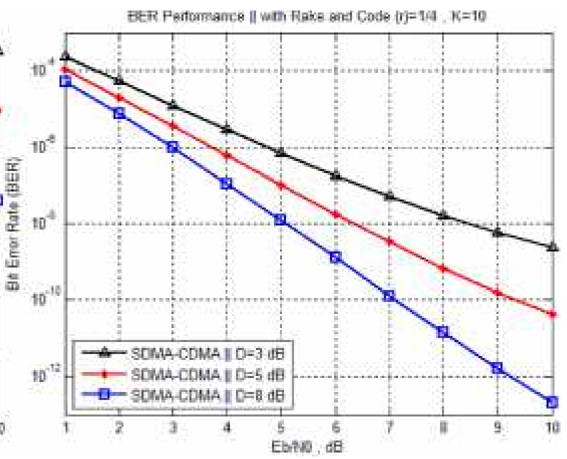


Figure (25) - BER performance as a function of Directivity (D)

9. Conclusion

Simulation supported by theoretical formulas was used in this paper to evaluate the performance and the capacity of asynchronous(reverse link)CDMA system and SDMA-CDMA system over a frequency selective multipath Rayleigh fading channel. Results shows a good agreement between simulation and theoretical approaches for different system parameters which represent a good verifications for the adopted simulation concepts. Results shows that at BER= 10^{-1}, using Rake receiver and increasing the number of fingers (M) from 2 to 3 , leads to increase system capacity from 15 to 30 users, and increase system performance from BER≈ 7×10^{-2} to ≈ 3.1×10^{-2} at Eb/No=4 dB. Results also shows that at BER≈ 10^{-2}, adding Channel coding to the system and increasing the code rate (r) from 1/2 to 1/3 leads to increase system capacity from 11 to 18 users and increase performance from BER ≈ 4×10^{-3} to ≈ 2×10^{-4} at Eb/No=6 dB. At BER=10^{-2}, increasing the spreading factor (Nc) from 16 to 32 leads to increase system capacity from 15 to 30 users and increase performance from BER≈10^{-3} to ≈2×10^{-5} at Eb/No=5 dB. At BER=10^{-6}, increasing the multipath factor (L) from 1 to 2leads to decrease system capacity from 22 to 11users and degrades system performance from BER ≈10^{-10} to ≈10^{-8} at Eb/No=8dB. Results shows that at Eb/No=6dB , increasing number of users (K) from 10 to 20 leads to degrade system performance from BER ≈10^{-5} to ≈10^{-3}. Using SDMA technique at Eb / No=3 dB , improves CDMA system capacity from 6 users to 35 users, and improves system performance from BER ≈ 10^{-4} to ≈ 10^{-6}. At BER= 10^{-6}, increasing the directivity of the Base station of the cellular mobile system from 3 to 5 dB , leads to increase system capacity from 11 to 17 users and increase performance from BER ≈ 10^{-6} to≈ 10^{-7} at Eb/No=5 dB .

References

[1] S. Kumar, M. Tuteja, and R. Singh, "BER Performance Analysis of CDMA Reverse Link under AWGN Channel", International Journal of Computer Applications (0975 – 8887)., Vol.21, No.2, pp.11-14, May 2011.
[2] K. Kim and I. Koo, "CDMA Systems Capacity Engineering", British LibraryCataloguing in Publication Data, 685 Canton Street, Norwood, MA 02062, 2005.
[3] M. M. Hossain and J. Hossain, "Error Performance Analysis to Increase Capacity of A Cellular System Using SDMA", journal of telecommunications, Vol.1, issue 1, pp.36-39, February 2010.
[4] C. A. Balanis and P. I. Ioannides, "Introduction to Smart Antennas", DOI:10.2200/S00079ED1V01Y200612ANT005, A Publication in the Morgan &Claypool Publishers' series, 2007.
[5] M. P. L¨otter and P. V. Rooyen, "Modeling Spatial Aspects of Cellular CDMA/SDMA Systems", IEEE communications letters, Vol. 3, No. 5, pp.128-131, May 1999.
[6] U.S. Goni and A.M.D. Turkmani, "BER Performance of a Direct-Sequence CDMA System in Multipath Fading Mobile Radio Channels with Rake Reception", 0-7803-1927-3/94/$4.00 @ IEEE, pp.747-751, 1994.
[7] T. S. Rappaport, "Wireless Communications: Principles and Practice", Upper Saddle River, NJ: Prentice Hall, February 1996.
[8] C. W. MengNan, "BER Analysis of RAKE Receiver in Rayleigh Fading Channels", 1-4244-0517-3/06/$20.00, 2006.
[9] P. Frenger, P. Orten, and T. Ottosson, "Code-spread CDMA using maximum free distance low-rate convolutional codes," IEEE Transactions on Communications, Vol. 48, No. 1, pp.135–144, Jan 2000.
[10] B. Butler, "AWGN Performance of Superorthogonal Convolutional Codes", 1516 for MILCOM, 2006.
[11] P. Wijesinghe, U. Gunawardana and R. Liyanapathirana, "Improved Performance Upper Bounds for Terminated Convolutional Codes in Rayleigh Fading Channels ", ECTI transactions on electrical eng., electronics, and communications Vol.8, No.1, pp.99-105, February 2010.
[12] B.U. Pedroni, V.A.Pedroni, R.D.Souza, "Hardware implementation of a Viterbi decoder using the minimal trellis", Communications, Control and Signal Processing (ISCCSP), 4th International Symposium on, pp.1-4, March 2010.
[13] P. Kumar, B.K. Kanaujia and M. Gangadharappa "BER Performance Analysis of Rake Receiver in Rayleigh Fading Channel for UMTS environment ", International Journal of Engineering Science and Technology, Vol. 2, No.6, pp.1690-1698, 2010.

تقويم اداء تقنية (SDMA-CDMA) الغير متزامنة في نظام التراسل الخلوي للهاتف النقال

ريم باسل سعدالله (طالبة ماجستير)* م.د.عبدالستار محمد احمد ** أ.م.د. قيدار مجيد قبع*

المستخلص

في السنوات الاخيرة, ازداد الطلب على خدمات اتصالات الهاتف الخلوي بشكل واسع جدا، ولعدم توفر امكانية تخصيص المزيد من الحزم الترددية لتلبية ذلك ، فقد اصبحت الحاجة ملحة لإدخال تقنيات جديدة تفضي الى تحسين الكفاءة الطيفية وبالتالي زيادة سعة التراسل للنظام الخلوي. ان نظام (SDMA) المدمج مع نظام (CDMA) ينتج عنه نظام رصين يجمع ما بين المناعة ضد تداخل الوصول المتعدد (MAI)والذي تؤمنه تقنية SDMA والقدرة على دعم عدة مستخدمين في نظام CDMA .

تم في هذا البحث محاكات اداء نسبة الخطأ لوحدة المعلومات BER في القناة الغير متزامنة (الصاعدة) لنظام التراسل الخلوي النقال نوع CDMA مع الاخذ بنظر الاعتبار قناة الخفوت من النوع رايلي و مشفر الالتفاف وفاك التشفير نوع فايتربي و مستقبل ريك. اظهرت نتائج المحاكات تطابقها مع النتائج النظرية لمختلف معاملات المنظومة , كعدد المستخدمين , معامل النشر , عدد المسارات لقناة الاتصال , عدد اصابع ريك, ونسبة التشفير. عند الأخذ بنظر الاعتبار توجيهية الهوائي المعتمد في المحطة الأساسية للهاتف النقال, اظهرت النتائج بأن نظام SDMA-CDMA قد أضاف تحسينات ملموسة على اداء النظام التقليدي نوع CDMA .

---

*جامعة الموصل/كلية الهندسة

**كلية الحدباء الجامعة