

## Design and Implementation a Proposed High Scalable CDMA System

Mahmood Zaki Abdullah Ph.D (Asst.Prof.)\*

Fadia Noori Hummadi (Asst. Lecturer)\*\*

### Abstract

The Code Division Multiple Access system CDMA is one of the modern technologies for transmitting and receiving data in the communication systems, the main aspect of this system focuses on transmitting multiple frames of data with different codes through a single channel. This paper will give a proposal approach for spreading and coding the base signal that can be increased the performance of CDMA system. This proposed approach applied a way for detecting errors in the transmitted frames of data through the parity check technique, as well as applying an adaptive filter for noise reduction that may be occurred in the process of sending and receiving data through the CDMA system, also this proposed system contains an additional stage for checking errors through evaluating the throughput of input and output data frames, this stage is very important to ensure that the whole CDMA system operates in a high performance with no errors. The verification of this approach is done by writing a program using a MATLAB source code. The obtained results give a view about enhancing the process of transmitting and receiving data through this system with no errors and damaged frames.

**Keyword:** Multiple Frames, Base Signal, Parity Check Technique, Transmitting and Receiving Data.

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\* Al- Mustansiriyah University

\*\* University of Baghdad

## 1. INTRODUCTION

Code Division Multiple Access (CDMA) system is one of the most popular multiple access communication system, the basic operation of this system depends on sending the base signal which has the original data with different codes, so this system has the capability of sending data with different codes by using some special encoding algorithms, these mixed transmitted frames can be named as spreading frames, which represents the base and encode signals through a certain operation called the spreading, the received spread frames are decoded again and produce the original data.[1]

Another digital communication multiple access systems can either use the time division multiple access (TDMA), which assumes sending multiple frames of data with multiple duration times, or use the frequency division multiple access system (FDMA), each of these multiple access systems has its special aspects for communications.[1]

## 2. RELATED WORKS

In this section focuses on reviewing some related works that gave many approaches and ways for developing the conventional CDMA system.

Ha H. Nguyen and Ed Shwedyk, proposed a new approach for construction of signature waveforms for synchronous CDMA systems based on dividing the users into sub groups with the same signature sequence but different chip waveforms to minimize the multiple access interference with modified error performance.[2]

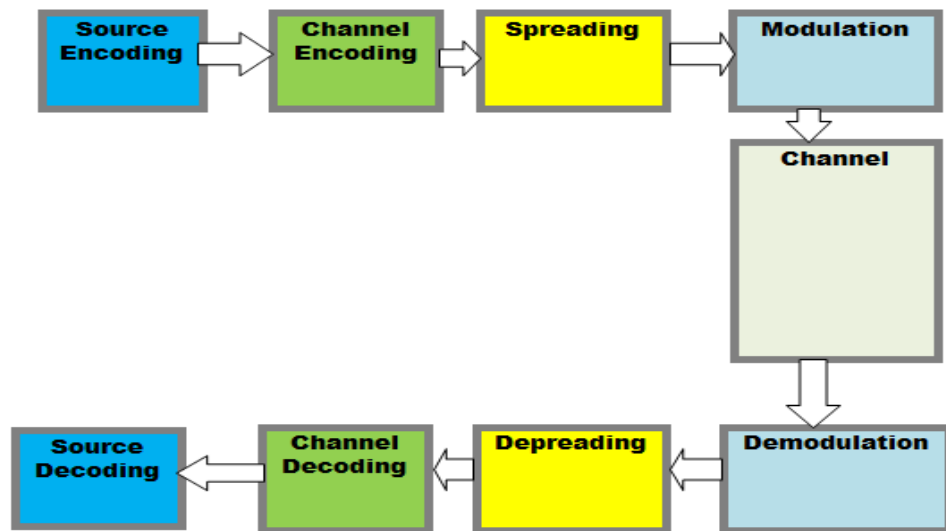
S.R. Sheikh Raihan, achieve a suitable matched filter and a new algorithm for generating code called a gold code for Direct Sequence Code Division Multiple Access (DS-CDMA) system.[3]

N.Kumarathan, K.Jayanthi and P.Dananjayan, present a new algorithm called Space Time Trellis Code (STTC) which apply the multiple input multiple output (MIMO) for site diversity and reduce cell interference in MC-CDMA system.[4]

Md. Sadek Ali, Md. Shariful Islam, Md. Alamgir Hossain, and Md. Khalid Hossain Jewel, propose a new way for improving a data rate at the Multi-Code Multi-Carrier Code Division Multiple Access (CDMA) with rejecting interference.[5]

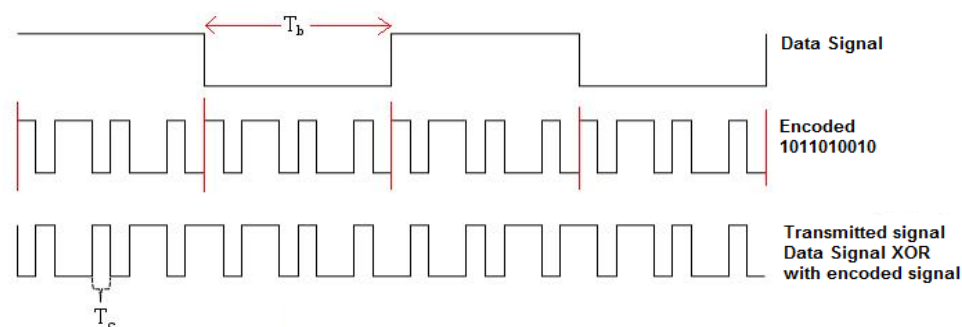
## 3. CONVENTIONAL CDMA SYSTEM

The process of transmitting and receiving data through the CDMA system can pass through many stages as shown in figure (1).

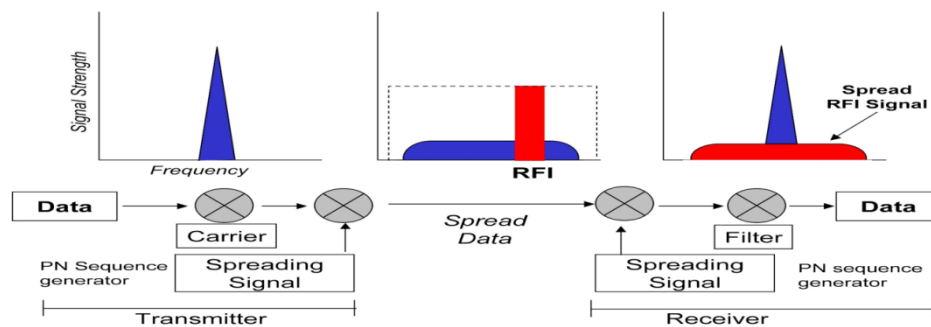


**Figure (1):** Shows the block diagram of conventional CDMA system. [4]

From figure (1), it is clear that each frame of the input information can be encoded with certain code to produce a unique encoded frame, the encoder circuit may be applied certain encode algorithm like xoring with certain fixed code, or applied special algorithm of coding such as walsh hadmard coding, then these encoded frames modulated according to a certain type of modulation such as Binary Phase Shift Keying (BPSK) modulation to produce a spread signal which can be transmitted through a channel, figure (2) shows the steps of encoded the input frames of data with pseudorandom signal, while figure (3) represents the procedure and shape of the spreading signal.[7]



**Figure (2):** Shows the algorithmic procedure and shape of encoded signal. [7]



**Figure (3):** Shows the algorithmic procedure and shape of spreading signal. [7]

The first step is to create a series of bits with a bit generator which represents the transmitted bits by the user,

$$b_i[n] \in \{0, 1\} \dots\dots\dots(1)$$

these bits are transferring through an encoder to produce a series of encoded frames,

$$bc_i[n] = f(b_i[n]) \dots\dots\dots(2)$$

these encoded frames are passing through a modulation circuit like BPSK to produce a sequence of symbols,

$$\alpha_i[n] = f(bc_i[n]) \dots\dots\dots(3)$$

and the mathematical form for the BPSK is [8],

$$S = \sqrt{\frac{E_b}{T_b}} \cos(k \cdot \pi) \dots\dots\dots(4)$$

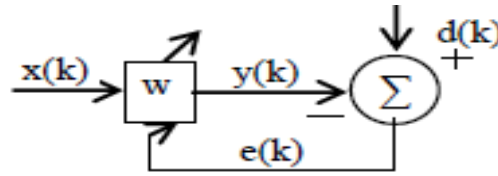
or may be used another types for modulation QPSK, PCM ..etc.[8], and an additional circuits such as Walsh coder, special sequencers, as well as filtering circuit to obtain a spread signal with low noise and interference [8].

#### 4. A PROPOSED APPROACH FOR CDMA SYSTEM

In this paper, the adaptation and enhancement for the conventional CDMA system can be occurred by proposing an additional algorithm for detecting and correcting the errors that may be occurred in the orientation of the transmitted and received frames of data. The proposed approach applied the algorithm of error detecting at the transmitting and receiving parts, the proposed approach applied the parity check technique to detect and find the errors in the received frames of data.

As well as this parity check circuit, the proposed approach adapt a suitable filter for noise reduction at the spread signal, this filters can be added at the sender and the receiver sides to eliminate the channel noise and reshaping the signals, this

adaptive filter achieves a way for noise reduction according to its self-capabilities about adjusting, figure (4) shows the basic scheme for this filter [9].



**Figure (4):** Shows the basic block diagram for adaptive filter. [9]

And the error can be calculated as follow:

$$e(k) = d(k) - y(k) \quad \dots\dots\dots (5)$$

This adaptive filter can apply simple algorithm steps through several iterations, the weights of these iterations can be updated according to the following equations: [9]

$$w(n) = [w_1(n), w_2(n), w_3(3), \dots\dots, w_k(n)]^T \quad \dots\dots\dots (6)$$

$$X(n) = [x_1(n), x_2(n), x_3(3), \dots\dots, x_k(n)]^T \quad \dots\dots\dots (7)$$

Where  $x(n)$  represents the input signal, and  $w(n)$  is the weight vector, the output signal of this filter will be  $y(n)$  and can be calculated as [9]:

$$y(n) = w^T(n-1) x(n) \quad \dots\dots\dots (8)$$

The error function can be also given as follow

$$e(n) = d(n) - y(n) \quad \dots\dots\dots (9)$$

Where  $d(n)$  represents the desired output function.

Finally, the proposed CDMA system proposed an additional stage for checking the performance of the whole system, this can be done by evaluating the throughput of input and output streams of information, the throughput can be evaluated according to the following equation:

$$\text{Throughput} = (\text{no. of information bits per a frame}) / (\text{Total Time}) \quad \dots\dots\dots (10)$$

Where the total time represents:

$(\text{Time})_{\text{total}} = (\text{Time of transmission frames } (T_f) + \text{Time of Acknowledgement frames } (T_a) + \text{Time of processing } (T_p) + 2 \text{ Time of propagation delay } (T_d)).$

Figure (5) shows the diagram for the proposed CDMA system, and the algorithmic flowchart for a proposed approach can be shown in figure (6).

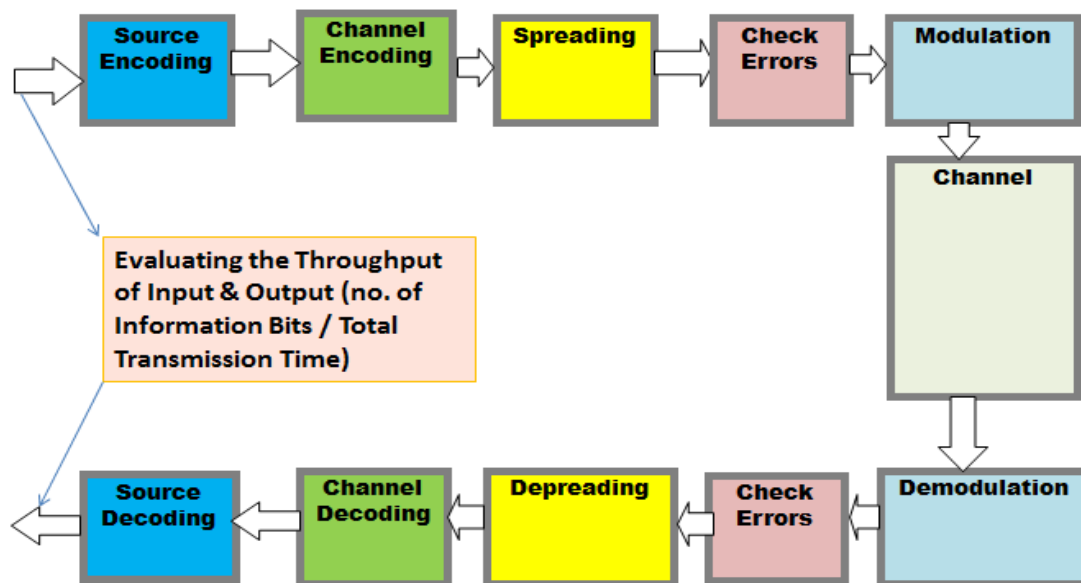


Figure (5) shows the diagram for the proposed CDMA system.

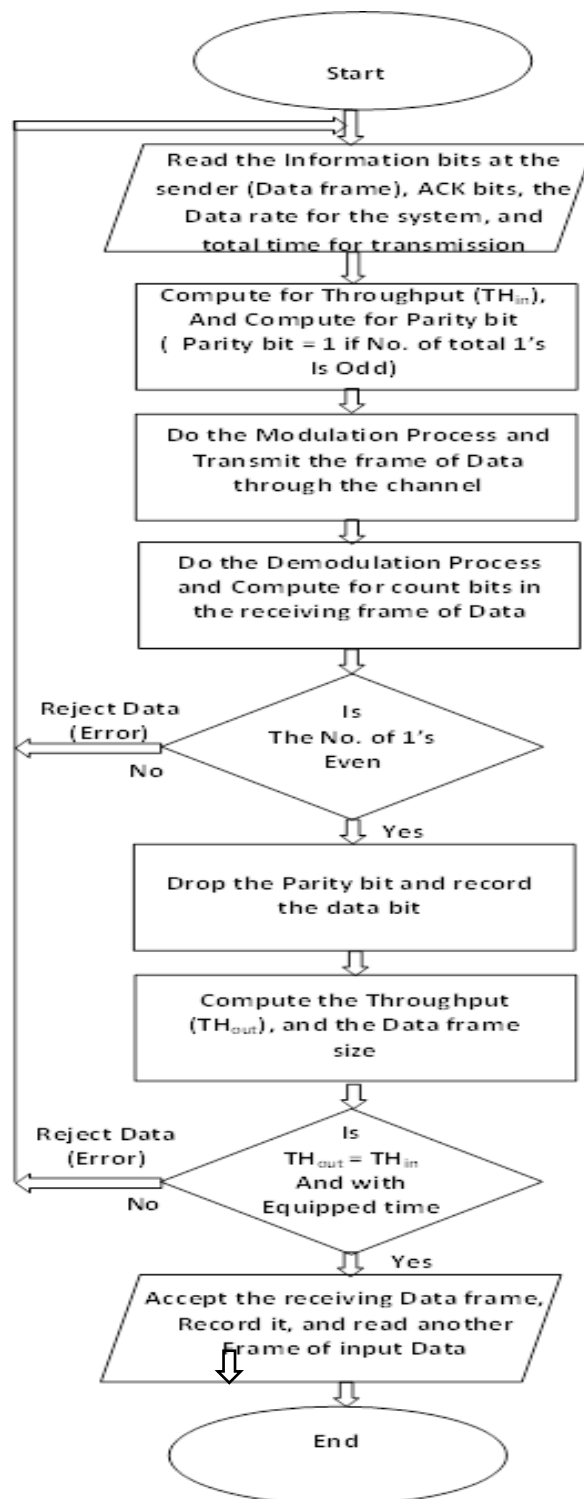
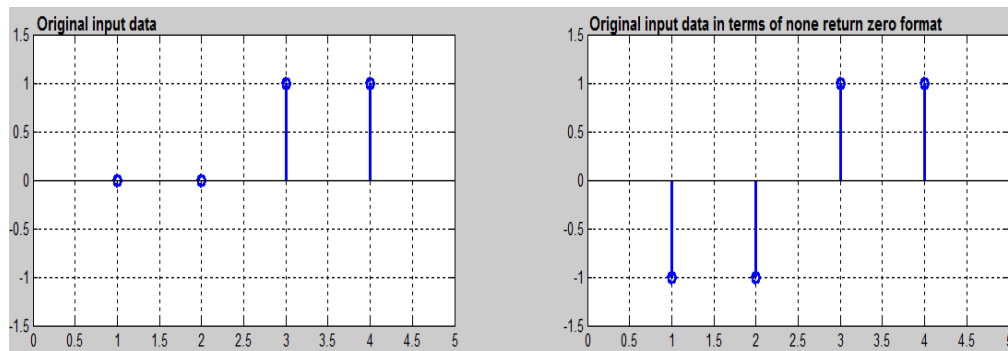


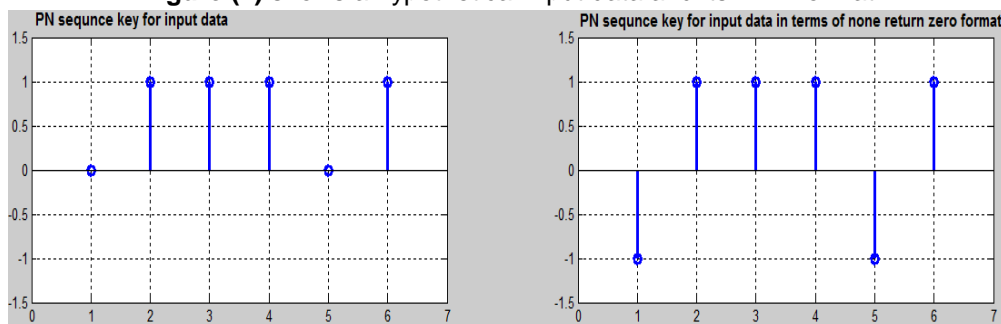
Figure (6) shows the flowchart for the proposed CDMA system.

## 5. IMPLEMENTATION AND PRACTICAL RESULTS

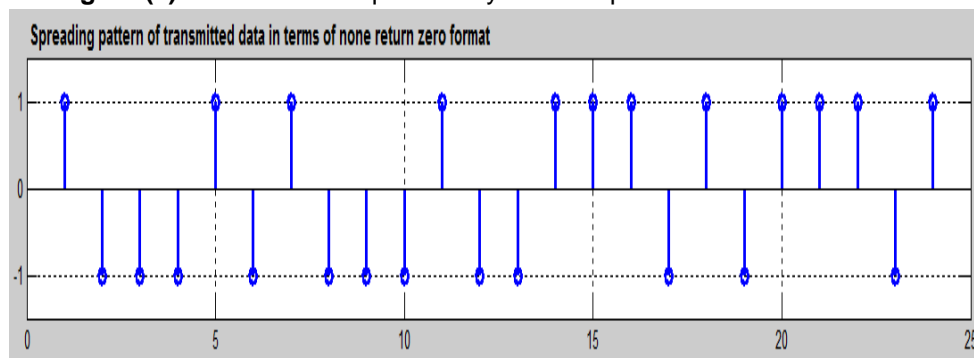
In this section, a MATLAB program can be written to test and check the behavior of a conventional CDMA system, and the obtained enhancement of our proposal approach, figure (7) shows the hypothetical input data and its none return zero signal, while figure (8) shows the PN sequence key for the input data, figure (9) shows a spreading pattern of the transmitted data in terms of none return zero format, finally figure (10) shows a received signal before and after spreading.



**Figure (7)** shows a hypothetical input data and its NRZ format



**Figure (8)** shows a PN sequence key for the input data and its NRZ format



**Figure (9)** shows a spreading pattern of the transmitted data in terms of NRZ



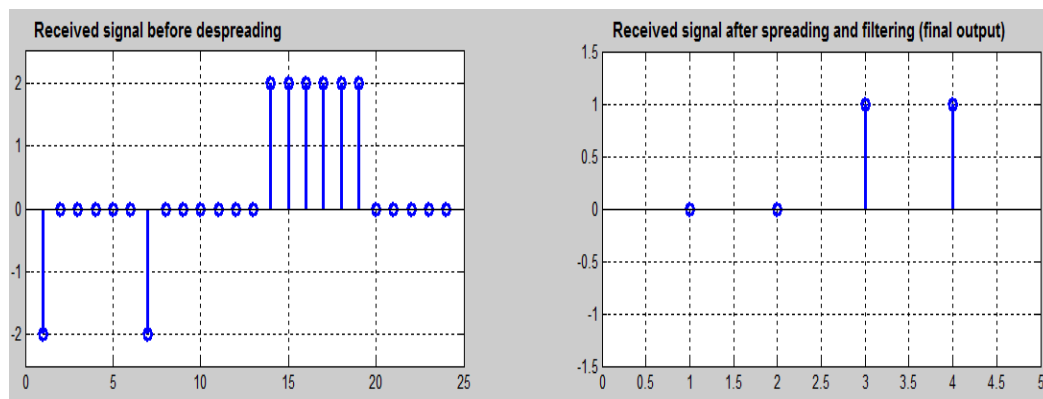


Figure (10) shows a received signal before and after spreading

## 6. CONCLUSION

It is obvious from the section of the implementation and practical results that our approach achieved a good performance for the conventional CDMA system due to applying the parity check technique for detecting errors in the transmitted data frames as well as applying an adaptive filter for reduction noise, figures (9) and (10) show the differences between the received signal before and after desreading process, the throughput checking stage checks and tests for the throughput of the whole CDMA system to ensure that there is no errors occurred and the CDMA system is operated with a high performance.

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## تصميم وتنفيذ مقترح نظام تقسيم مشفر متعدد الوصول ذو نطاق واسع

أ.م.د. محمود زكي عبد الله\*

م.م. فادية نوري حمادي\*\*

### المستخلص

يعتبر نظام التقسيم المرمز متعدد الوصول من أهم التقنيات المستخدمة في الإرسال والاستقبال في أنظمة الاتصالات، من أبرز السمات الرئيسية لهذه التقنية هي إمكانية إرسال بيانات ذات شفرات مختلفة ترسل خلال قناة واحدة. هذا البحث سيقدم أنموذجاً مقترحاً لانتشار وتشفير إشارة القاعدة للمعلومات المراد إرسالها بالشكل الذي يزيد من كفاءة هذا النظام، وبالتالي يجعل هذا النظام يستخدم ويعمل ضمن نطاق واسع من المستخدمين وبدون ضوضاء وبسرعة إرسال عالية. هذا الأنموذج المقترح أعتمد على وجود طريقة لكشف الأخطاء الحاصلة نتيجة عملية الإرسال والاستقبال في هذا النظام، إضافة إلى تطبيقه أحد المرشحات المتقدمة التي ساهمت بتقليل وإخماد الضوضاء الحاصلة والمرافقة لعملية الإرسال والاستقبال في هذا النظام، كما أن هذا النظام المقترح يحتوي على مرحلة إضافية لحساب إنتاجية هذا النظام (عدد البتات المرسله خلال زمن معين) بالنسبة للبيانات الداخلة والخارجة، هذه المرحلة مهمة جداً لضمان النظام (CDMA) المقترح بأنه يعمل بأداء عالي وبدون أخطاء. ولغرض التحقق من جودة هذا الانموذج الافتراضي فإنه تم إعداد برنامج باستخدام الاوامر الخاصة ببرنامج الماتلاب MATLAB ، إذ أعطت النتائج المستحصلة مظهراً واضحاً للتحسين الذي حصل في عملية إرسال واستقبال البيانات المرسله من خلاله بدون حدوث أي خطأ أو ضوضاء في عملية الإرسال.

\*الجامعة المستنصرية

\*\*جامعة بغداد