Bit Rate and Security Enhancement for DS-JCDMA using IFFT and H-Polarity, V-Polarity Transmitter Waves

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ABSTRACT
High bit rate and more security for physical layer are very important today therefore they grow and evolution because of the large size media and accuracy of the information transmitted now, But that cannot be changing generation systems every time, Therefore we need a programmable system and immediate change by re-change protocol or changes completely through programming devices to become much more affordable, customizable for costumer users and Consecration; Therefore we propose the physical layer system that can be programmable using the system that already work like LTE-OFDM, W-CDMA, CDMA2000 … etc. this system is using n-QAM and n-QPSK as base data instead off 1,0 binary system but transmitter by MC-CDMA or OFDM-CDMA (MC-DS-JCDMA) in both H-Polarity and V-Polarity waves with more security using JPN instead off PN. The results were without channel estimator or equalizer acceptable in 24dB with high bit rate and low bandwidth in both selective and flat fading channel added with AWGN and Doppler Effect.

General Terms
Communication system, LTE, LTE-A High bit rate Novel idea for G5

Keywords
DS-CDMA, OFDM, JCDMA, JPN, LTE, LTE-A G4, G5..

1. INTRODUCTION
Communication system today are growing in rapidly then the needing for high speed or high bit rate with limit bandwidth or limit frequency for that the multiple inputs multiple outputs (MIMO) system can help with limitation band width frequency (transmitted many users with same frequency) like Time Division Multiplexing Access (TDMA) and Code Division Multiplexing Access (CDMA) or Multi Carrier Code Division Multiplexing Access (MC-CDMA) like Orthogonal Frequency Division Multiplexing companies with CDMA (OFDM-CDMA)[1]. Third generation system (3G), extension with second generation system in 2000-2001 [2], those generations using TDMA and CDMA were increasing capacity ten times from the first generation for mobile (Frequency Division Multiplexing Access FDMA) 1992. The 3G like UMTS (Universal Mobile Telecommunication System) and CDMA2000 are introduced in 2001 [3] with higher data rates than all generations and WCDMA with data rate (64Kbps-2Mbps).But the users now (in the 3'rd thousand) will be big number, and the frequency is limiting with limit bits rate for the users. LTE (or Long Term Evolution), it is a standard 4G for high-speed data wireless communication (100 Mb – 1 Gb), for mobile and data. It is based on the GSM and UMTS network, increasing the capacity and bits rate by using different radio interfaces together with network improvements [4][5].The world's first publicly available LTE service was launched by Telia Sonera in Stockholm and Oslo on December 14, 2009 [4]. In 2011 a paper publish about using n-QPSK and n-QAM with Direct Sequence CDMA (DS-CDMA) in the name of JCDMA[6], the mine idea is that the JCDMA outputs (see Figure 18) in the final is like analog constellation points shape (before the transmitters) and we can transmitter analog single with infinite bit rates by any analog transmitter like Frequency modulation "cosine and sine" functions, Sections will be divided into the following: the second section will be including the DS-JCDMA and make an example, the third section includes the proposed system, the forth section is the analysis and the study of performance of all system finally the fifth section is the conclusions.

2. COMPLEX NUMBER IN CDMA
First, Code Division Multiple Access (CDMA) is make like a unique name (orthogonal) for every user data to ensure at demodulation will be easy to the user find its data as the equations below from Figure 18 is serial to parallel is 1:N_{k-1}, then:

$$A = \begin{bmatrix} \mathrm{Code}_1 \\ \mathrm{Code}_2 \\ \vdots \\ \mathrm{Code}_n \end{bmatrix}, \text{ Then: } AA^{*T} = I_{n\times n} \quad (1)$$

$$\mathrm{Code}_n = \{C_{(n,m)}\}_{m=1}^{L} \quad (2)$$

$$d_{cn} = U_n PN_n Code_n = U_n PN_n \{C_{(n,m)}\}_{m=1}^{L} \quad (3)$$

$$d_A = \sum_{k=0}^{n-1} U_k PN_k Code_k = \sum_{k=0}^{n-1} U_k PN_k \{C_{(k+1,m)}\}_{m=1}^{L} \quad (4)$$

And for many chips can be transmitter the total summation can representing as a sequence notation as equation (5) if the number of chips is (G):

$$d_A^G = \left\{\sum_{k=0}^{n-1} U_K^G PN_K^G Code_k\right\}_1^G = \left\{\sum_{k=0}^{n-1} U_K^G PN_K^G \{C_{(k+1,m)}\}_{m=1}^{L}\right\}_1^G \quad (5)$$

For minimum Bandwidth for one chip in equation (4, 5), the parameter must be in the minimum length or dA must be minimum sample and that can be if and only if Codek be in the minimum; but it difficult to found minimum code in this case (and must be orthogonal) only if the length of it will be at least is equal to number of users, therefor the equation for JCDMA will be as equation (5) as below

$$d_A^G = \left\{ \sum_{k=0}^{n-1} Uq_K^G JPN_K^G Code_k \right\}_1^G = \left\{ \sum_{k=0}^{n-1} Uq_K^G JPN_K^G \{C_{(k+1,m)}\}_{m=1}^L \right\}_1^G \quad (6)$$

Where $\mathbf{Uq_K^G = 2^n QAM\ or\ 2^n QPSK}$ (n here is S/P rate 1: n), and $\mathbf{JPN_K^G}$ is Complex Number Pseudo Noise can be change may be two bit in same time, as shown:

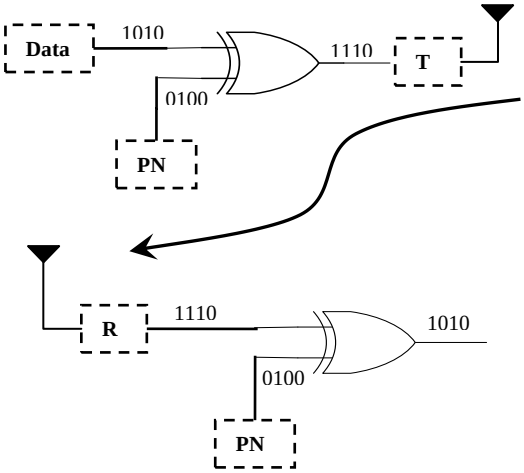

Fig 1: PN [6]

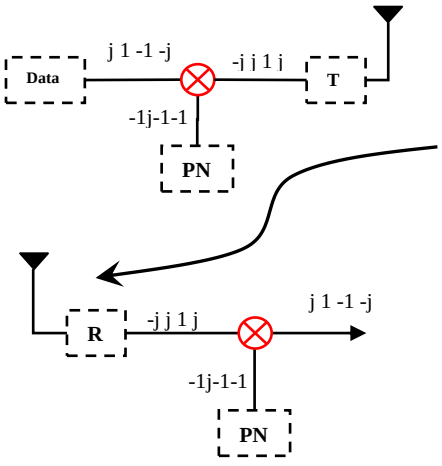

Fig 2: JPN [6]

PN can be "1" or "0" , "1" or "-1", but JPN can be as "1" , "-1" , "j" , "-j" and can be "1+j" , "1-j" , "-1+j" or "-1-j" then it can change two or more bit in same time it is more security. PN (Pseudo Noise) it is made up noise can be removing from the data in simple way for example XOR gate. But the Security Level Power (SLP) in binary form will be calculating from the equation:

$$SLP_{PN} = 2^n \quad (7)$$

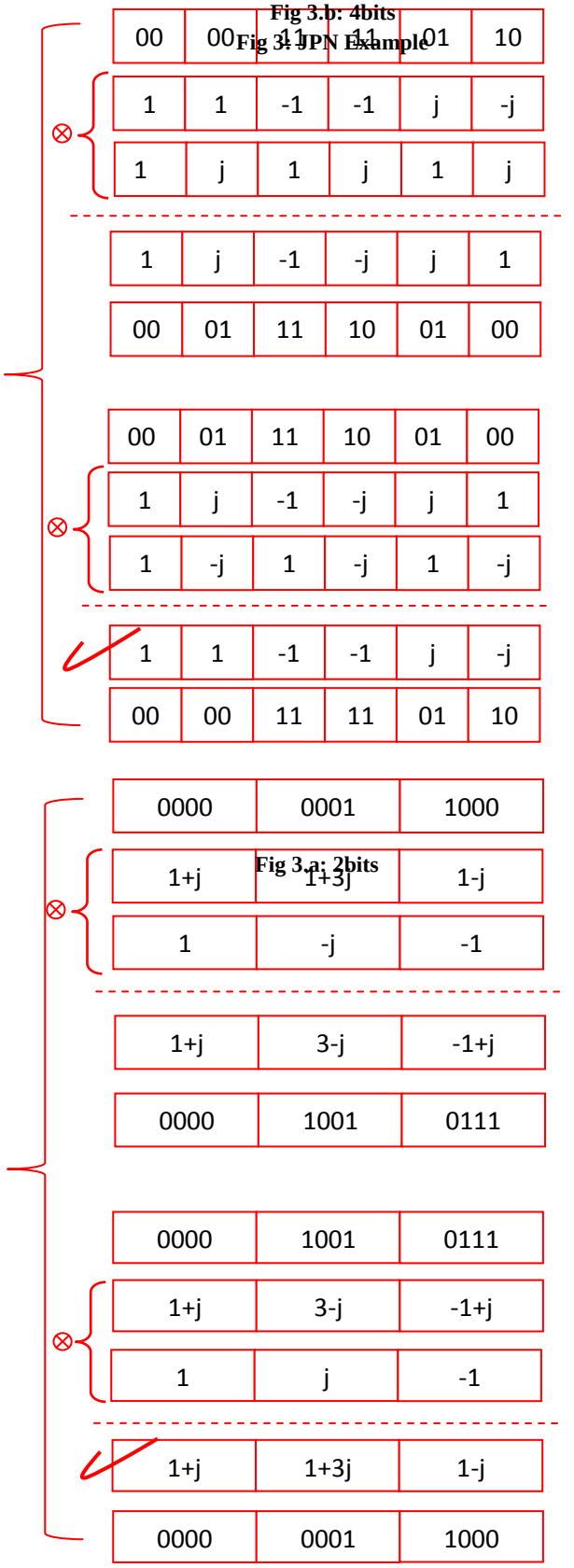

Fig 3.b: 4bits

Fig 3.a: 2bits

Fig 3: JPN Example

Where (n) is the number of sequence in pseudo noise that will be using in scrupling, as PN can use 1 and 0 and for more complexity, using complex number as pseudo noise like shown in the numerical example, the Security Level Power (SLP) for JPN will be:

$$SLP_{JPN} = 4^n = (2^2)^n = 2^{2n}2^{n+n} = 2^n * 2^n$$

$$= SLP_{PN} * SLP_{PN} \quad (8)$$

Where n is the sequence length, if the sequence length for PN and JPN is 10 then:

$$SLP_{JPN} = SLP_{PN} * SLP_{PN} = 2^{10} * 2^{10} = 1024 * 1024$$
$$= 1kB * 1kB = 1MB$$

Proposed systems for JCDMA and JPN are completed shown in Figure 10 in the next section will introduce the proposed systems for two polarity JCDMA and JPN with OFDM (or LTE), and how can be programing, the receiver or the end user or the down link can be as:

$$d_h^G = \sum_{k=0}^{n-1} \{d_A^G Code_h\}$$

$$= \Sigma \left[\left[\sum_{k=0}^{n-1} U_k PN_k \{C_{(k+1,m)}\}_{m=1}^{L} \right] * \{C_{(h,m)}\}_{m=1}^{L} \right] \quad (9)$$

If in the equation (9) as Figure 10:

$$\sum \{C_{(k+1,m)}\}_{m=1}^{L} * \{C_{(h,m)}\}_{m=1}^{L} = \begin{cases} 1 \text{ or constant} & \text{if } k+1 = h \\ 0 & \text{if } k+1 \neq h \end{cases} \quad (10)$$

3. PROPOSED SYSTEMS FOR JCDMA USING H & V POLARITY

Horizontal and Vertical polarity (H-p & V-p) using in satellite communication downlink channels to reduce using frequencies interferences and bandwidth, but JCDMA it is already reduce bandwidth as shown in Figure 4:

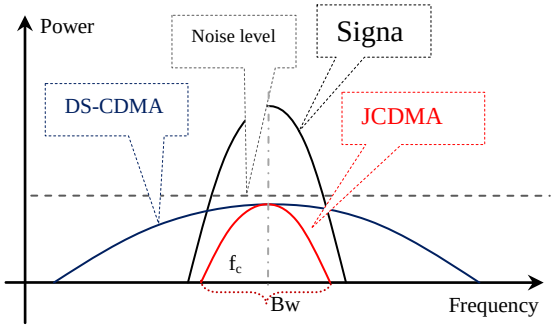

Fig 4: CDMA & JCDMA Bandwidth [6]

The proposed system will use H-p & V-p from base station to the end users (downlink) when transmitter at the antennas as shown in Figure 5, for both single and multi-antennas and both LTE and LTE-A (for this paper using OFDM just IFFT-FFT as transmitter with 1-transmitter 1-resiver antenna), Table 1. shows us the most important variables and parameters that will compare them and try our new system with OFDM, 192 subcarrier [1,2] and Table 2. Shows us the most important variables and parameters that will be or can be programmable.

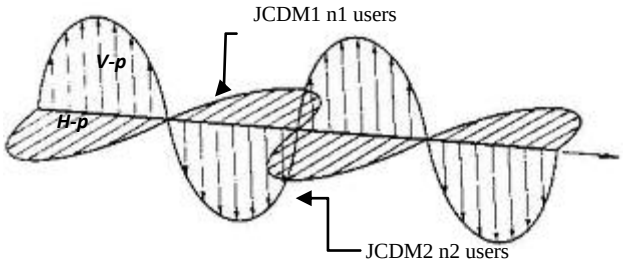

Fig 5: JCDMA H-p and V-p waves

Table 1. The parameter will be study in the paper

Parameters	Types
Number of users	8
Transform Where (C)=complex matrix and (R)=not complex matrix, real no.	1-Safe matrix ($_0\mathbb{S}_8$)[7], (C) 2-Walch-Hadamard (W8),(R) 3-Fast Fourier Transform matrix FFT8x8 ,(C) 4-Wavelet Transform matrix Dub28x8 (R) 5-JWavelet Transform matrix(WSafe2)8x8, (C) 6-Slantlet transform matrix SLT8x8, (R)
Number of chips	8
Number of bits/users/chip	8*log2(no. points)
Total Number of bits/packet	8*(Number of bits/users/chip) No. of packet = 300 each time
Channel study model	1-Flat Fading +AWGN, 2-Frequency Selective Fading+ AWGN.
Doppler shift	50,100,200Hz
Modulation\user	2PSK,4QAM,8QAM,16QAM,32QAM,64QAM
Modulation ways	IFFT.
No. antennas	1-TX to 1-RX
Security	For all the value of JPN=1

Table 2. The parameter that can be programing

Parameters	Options
Number of users	n with high bits rate, 2n with normal bits rate
Transform Where (C)=complex matrix and (R)=not complex matrix, real no.	1-Safe matrix ($_0\mathbb{S}_n$), (C) 2-Walch-Hadamard (W-Hn),(R) 3-Fast Fourier Transform matrix FFTnxn ,(C) 4-Wavelet Transform matrix Dub2nxn (R) 5-JWavelet Transform matrix(WSafe2)nxn, (C) 6-Slantlet transform matrix SLTnxn, (R) . .
Number of (bits/users/chip= Nn)	Nn =1 CDMA95-IFFT, Nn =2 CDMA2000-IFFT Nn =3 JCDMA-IFFT, Nn =4 JCDMA-IFFT ……
No. of antennas "MIMO"	Tr-TX\Rr-RX, where Tr=No. of transmitter and Rr=No. resiver
Security	Any length for JPN

4. RESULT AND DISCUSSION

The figures from 11-16 will be shown that we can make study and compare between JCDMA-IFFT and OFDM (OFDM using Zero Padding, Cyclic Prefix and Channel Estimator with Channel Compensating, While JCDMA-IFFT has no one of this), the results explain it can be have high bitrates with same chip or smallest for same user in the same time and it is more batter then the old way in fact it can be realize in figure below, the bandwidth of JCDMA may be the same bandwidth of signal or more from it.

From Figure 6 to Figure 16 the it can be see that in the first (or 1bit/user/chip and 2bits/user/chip) it (for all codes) the same in the SNR and equal 24 dB but the data are doubled twice, The effect of the power is taken after normalize, This factor (Normalize) will be multiply the signal before transmitter and divided on it after receiver to be inshore that the signal for all system in the same power. The Conclusions will be as:

- It can be seen that from Figure 11 to Figure 16 the proposed system (H-V JCDMA-IFFT) it is have more bit rat more than the classical system special when using two wave H-p and V-p and has high bits/user/chip it can see that the system (New one) the data rate is doubling from then 1 bit/user/chip with same power transmitted.
- The system if we see the Table 2 is programmable for customize systems
- The resulting showing that it can be increasing bit rat without increasing bandwidth, there for it can be a flexible system all.
- The system can work with any complex code (matrix) and real one that is good for more security see Figure 12 to Figure 16.
- The SNR to BER for the system is very good if we compared it with OFDM that is the minimum SNR at 2PSK and 4QAM on the Flat channel and 192 samples is 32dB SNR [1].
- The system not need to pilot, cyclic prefix, zero padding and channel estimator with channel compensating.
- In the case of JPN we found that the security power is not compared with the number of iterations to the new way.

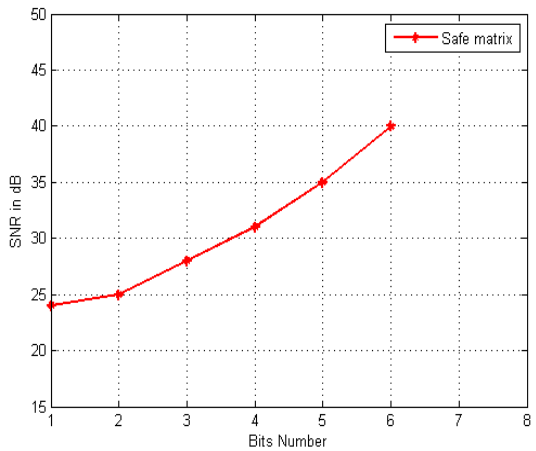

Fig 6: Performance of Safe matrix in Flat fading channel with 50 Hz Doppler shift

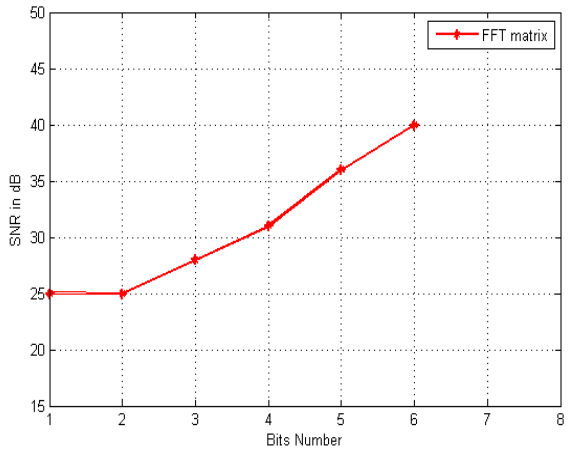

Fig 7: Performance of FFT matrix in Flat fading channel with 50 Hz Doppler shift

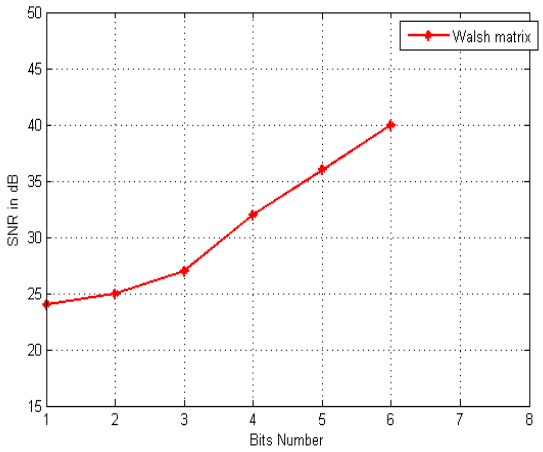

Fig 8: Performance of Walsh matrix in Flat fading channel with 50 Hz Doppler shift

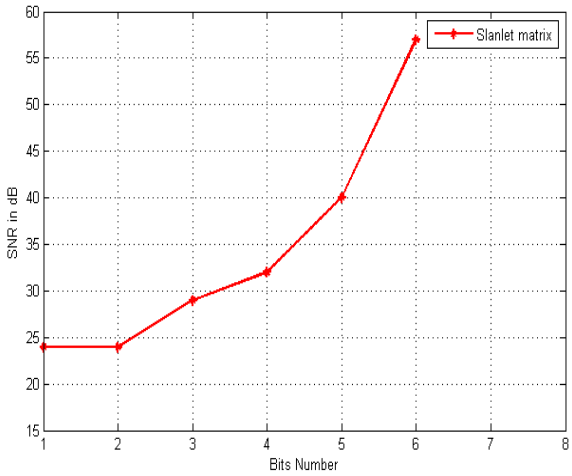

Fig 9: Performance of Slantlet matrix in Flat fading channel with 50 Hz Doppler shift

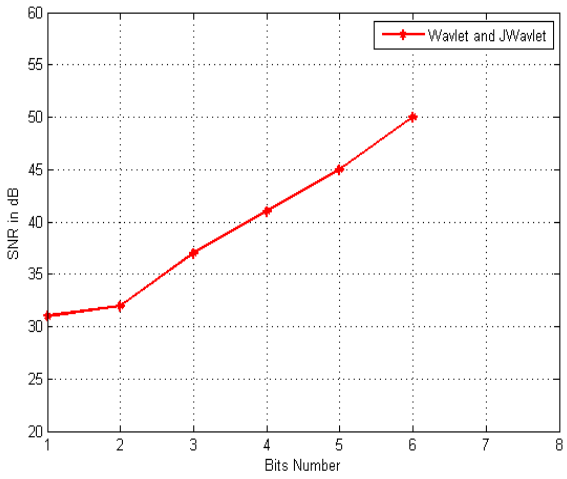

Fig 10: Performance of Wavelet and JWavelet matrix in Flat fading channel with 50 Hz Doppler shift

The DS-JCDMA has enhanced in performance if compare with OFDM because OFDM in Transmitter divided by number of subcarrier (where $IFFT=FFT^{-1}=FFT^{t}/n$, n=number of points) but in DS-JCDMA it sum of all users see equation 10 (if 1 or constant >1), to inshore we make normalize for both system, from that the enhancement come.

5. ACKNOWLEDGMENTS

We are now doing the steps of registering this new DS-JCDMA, DS-JCDMA-IFFT and H-V-DS-JCDMA-IFFT inventions of:

- DS--JCDMA Working with LTE, LTE-A, WiMAX64.
- Customized DS-JCDMA (**real time control & programmable**).
- Using DS-JCDMA in multiple applications (I**oT**).
- DS-JCDMA working in Multipath Channels [1].

If our research is accepted by the companies we'll be ready to give the details about the above inventions but after signing an official agreement with the companies.

The JCDMA has enhanced capabilities and more powerful than the traditional CDMA types as shown below:

- JCDMA can work perfectly without the need to Channel estimators and without the need to Equalizers.
- When using JCDMA, each subscriber or user can get the required bit rate because the JCDM can work and control with multi bit rates simultaneously depending on the needs of the users' applications.
- JCDMA needs less Bandwidth than the traditional CDMA types.

6. REFERENCES

[1] Saifuldeen Abdulameer Mohammed "Space Time Block Code for PCC, MC-CDMA Using Slantlet Transform" M.Sc Thesis, June 2007, Electrical Engineering Department, College of Engineering, Baghdad University.

[2] "OFDM as a modulation technique for wireless communications, with a CDMA comparison", Online: http://www.skyofdm.org 1999.

[3] J. Huber, "3G Forum Leveraging Spectrum Capacity In Accordance with 3G Deployment", 3G Forum 17th-18th April 2001, Washington D.C.,Online:http://www.umtsforum.org/ipapers/Leveraging_Spectrum_Capacity.pdf.

[4] Telia Sonera first in the world with 4G services (http:// www. teliasonera. com/ en/ media/ press-releases/ 2009/ 12/teliasonera-first-in-the-world-with-4g-services/).

[5] Erik Dahlman, Stefan Parkvall, Johan Sköld "4G – LTE/LTE-Advanced for Mobile Broadband", Academic Press,2011, ISBN 978-0-12-385489-6

[6] Saifuldeen Abdulameer Mohammed, "Proposed System to Increase the Bits rat for User in the Chip packet using Complex number in Code Division Multiplexing Access and Pseudo Noise (JCDMA and JPN)", Published in the proceeding of the Second Scientific Conference of Electrical Engineering University of Technology 4-5 April 2011 CE13 pp 200-211.

[7] Saifuldeen Abdulameer Mohammed, "A Propose for aQuadrature – Phase as Full Orthogonal Matrix TransformCompared with FFT Matrix Multiplication and Appliedin OFDM System (Safe Transform the Fourier Twins)",Doi :10.7321/jscse. Vol. 2, No.6.5, Jun pp : 56 – 72

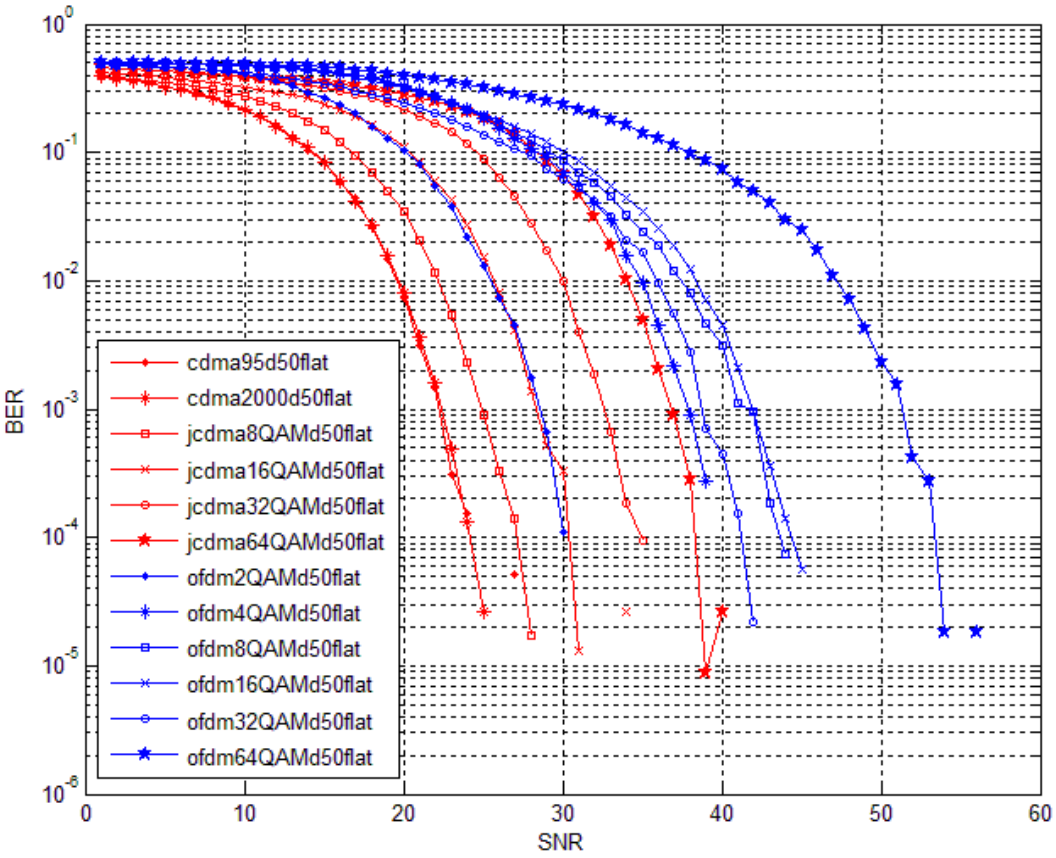

Fig 11: Performance of Flat Fading Channel with 50 Hz Doppler Shift

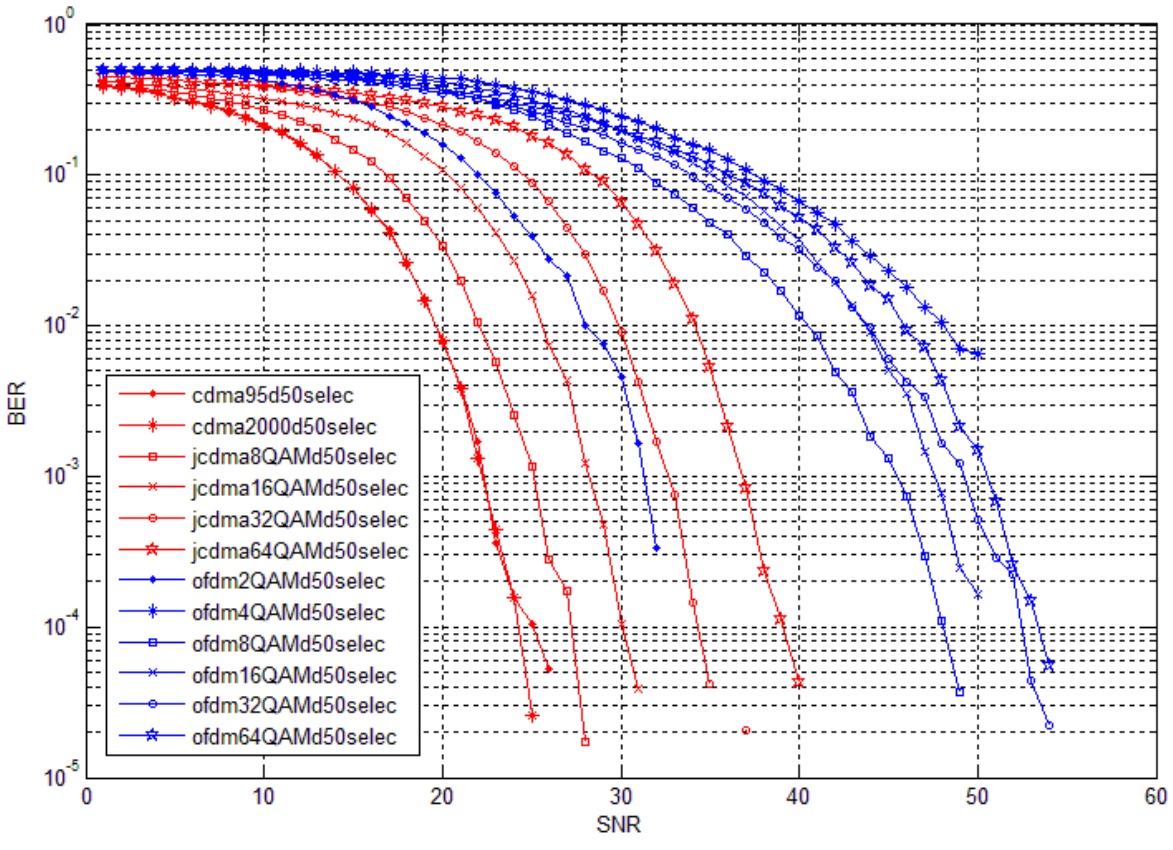

Fig12: Performance of Selective Fading Channel with 50 Hz Doppler Shift

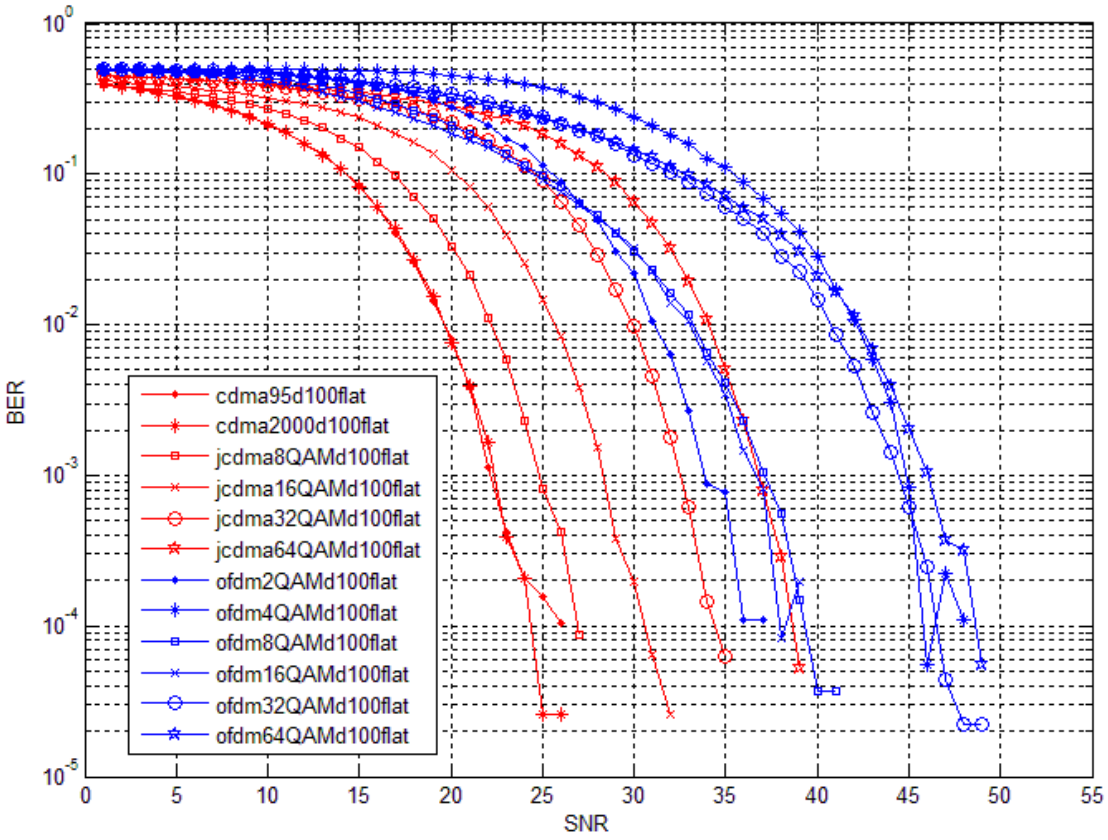

Fig 13: Performance of Flat Fading Channel with 100 Hz Doppler Shift

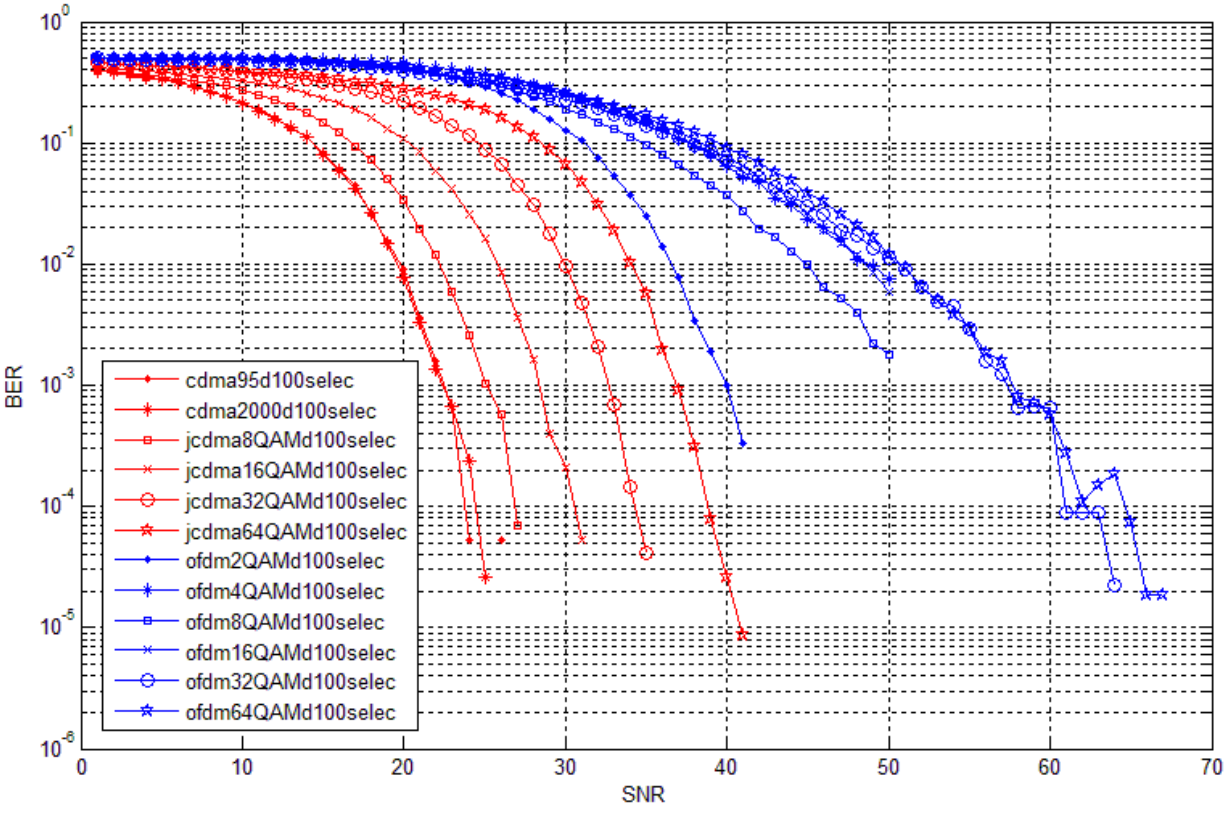

Fig 14: Performance of Selective Fading Channel with 100 Hz Doppler Shift

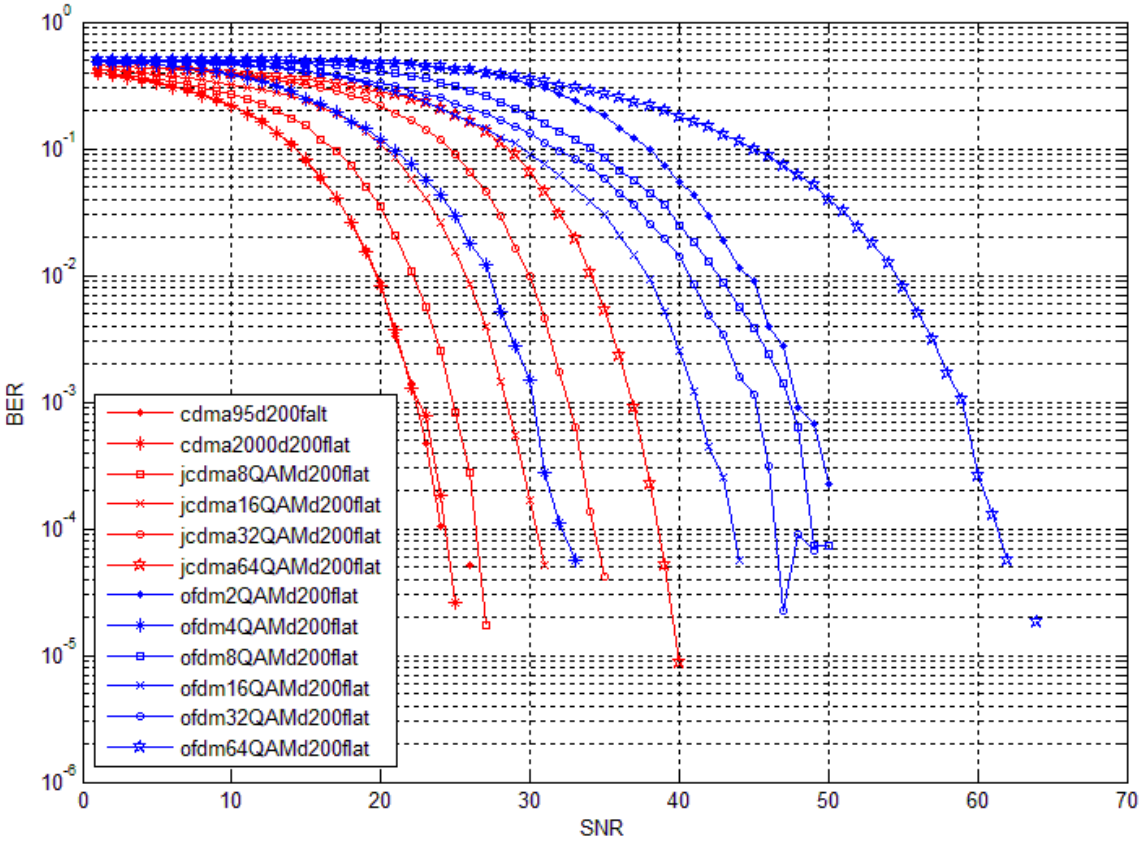

Fig 15: Performance of Flat Fading Channel with 200 Hz Doppler Shift

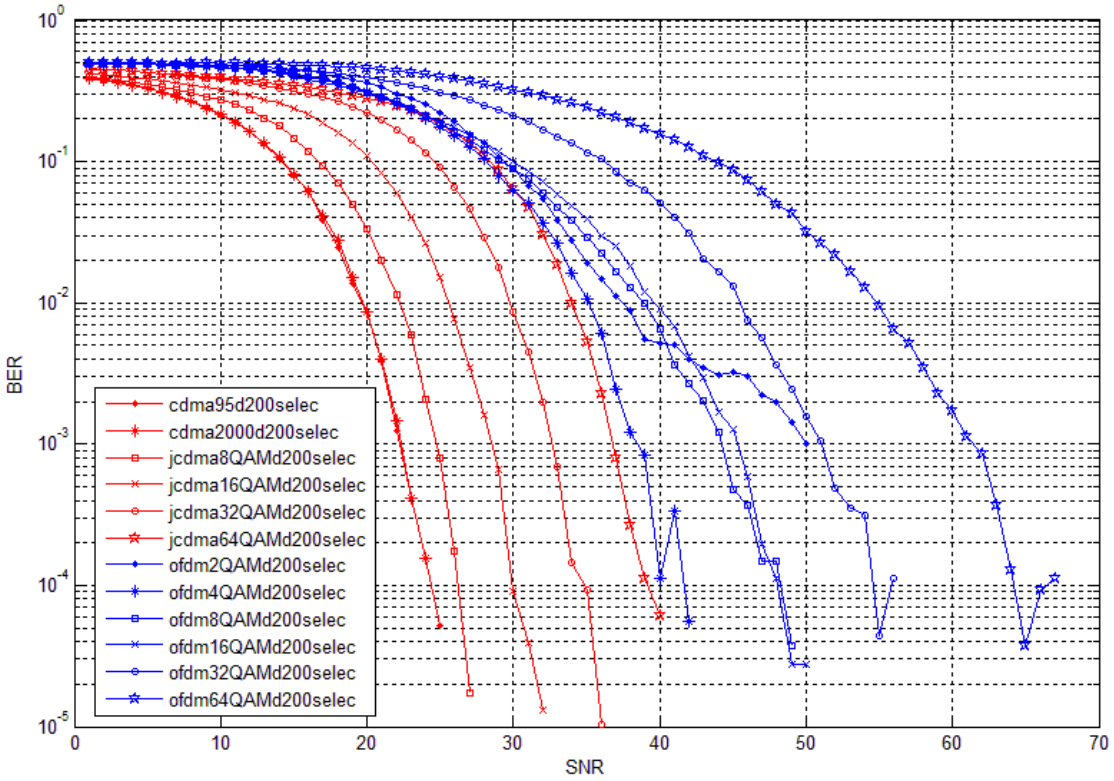

Fig 16: Performance of Selective Fading Channel with 200 Hz Doppler Shift

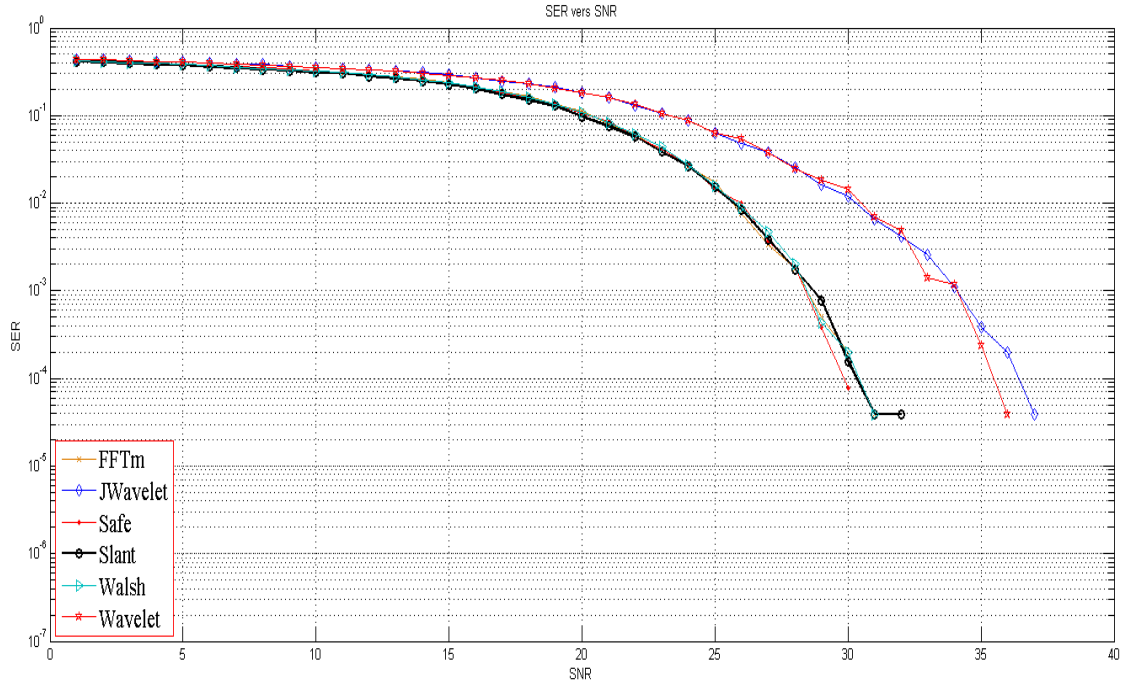

Fig. 17. Performance of the all proposed systems and codes (SNR and BER with number of 4-bits /user/chip in the selective fading channel with 100 Doppler).

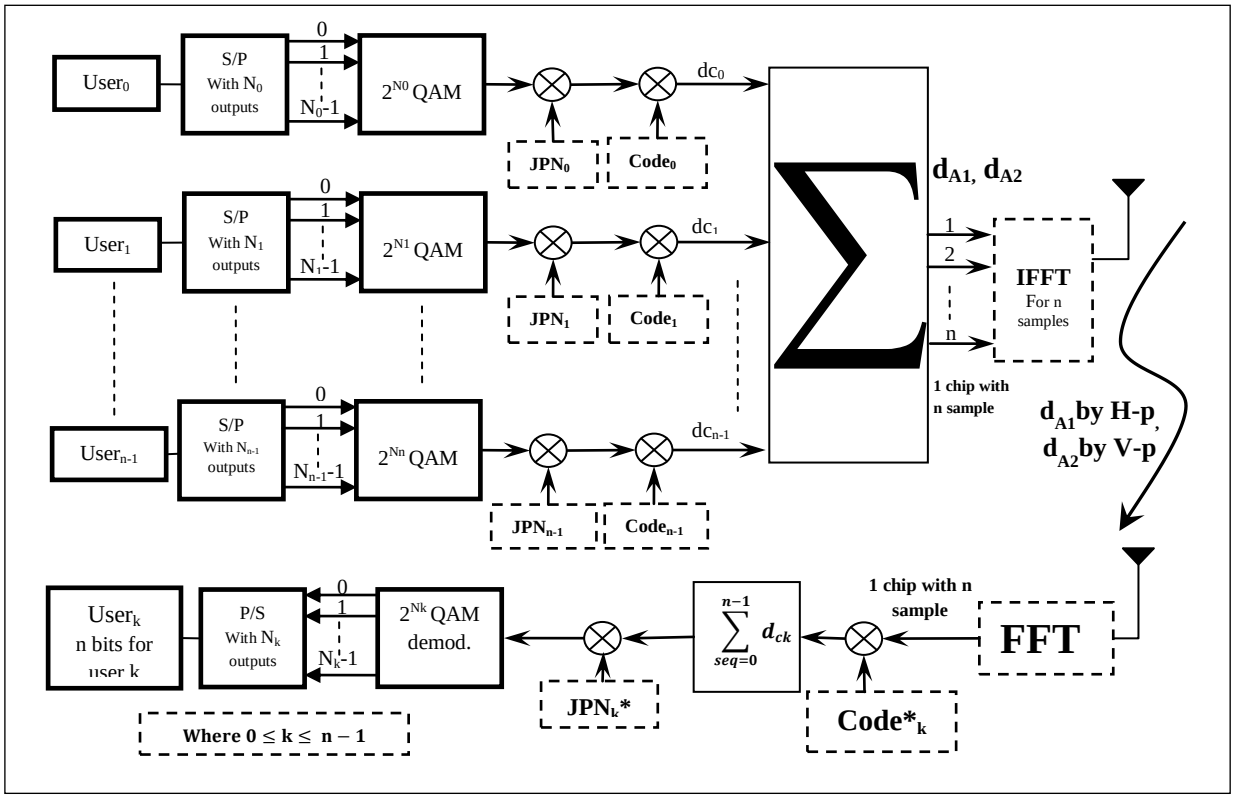

Fig. 18.V-p and H-p JCDMA & JPN system with FFT