International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

DESIGN OF MODIFIED FULL RATE QSTBC FOR FADED MIMO OFDM SYSTEM WITH LESS BER

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Abstract: In this works, the effects of nonlinear distortion, especially the phase distortion, caused by HPA in the MIMO-STBC system with transmit/receive filtering is analyzed in detail. It is shown that the nonlinear distortion impact in MIMO-STBC is somewhat different to what incurred in the SISO system. Then, limitations and defects from previous publications are figured out. Based on the precise analysis, a phase estimation algorithm and a QSTCB fading matrix have been being proposed. The drafted codes are then analyzed concerning the bit error rate performance and the spectral efficiency with optimal as well as suboptimal receiver structures. In the second part of this work, the combination of Space-Time Codes with conventional channel coding techniques is considered. This work is implemented on MATLAB-2018b EDA tool and tested on the same with various noise channels environments.

Keyword-ISI: Inter-symbol interference , ICI: Inter-channel interference, STBC: Space-Time Block Code, QSTBC: Quasi Space-Time Block Code, HPA: High power Amplifier, PAPR: Peak Signal to power ratio

I-INTRODUCTION

In current correspondence frameworks developing interest of media administrations and the development of Internet-related substance lead to expanding interest to fast interchanges. As of late, space-time block codes (STBC) have acquired a lot of consideration as a successful send variety method to furnish dependable transmission with high pinnacle information rates to build the limit of remote correspondence frameworks. In this proposal, the execution of STBC-OFDM is dissected under multipath Rayleigh blurring channels with BPSK tweak, in different receiving wire choice strategies, and with or without the PAPR decrease method (cutting).

High ghostly effectiveness and high transmission rate are the difficult prerequisites of future remote broadband interchanges. In a multipath remote channel climate, Multiple Input Multiple Output (MIMO) frameworks prompt the accomplishment of high information rate transmission without expanding the complete transmission force or data transfer capacity. Different Input Multiple-Output reception apparatus frameworks are a type of spatial variety. A successful and down to earth approach to moving toward the limit of MIMO remote channels is to utilize space-time block coding in which information is coded through existence to improve the unwavering quality of the transmission, as excess duplicates of the first information are sent over free blurring channels. At that point, every one of the sign duplicates is joined at the beneficiary in an ideal manner to remove however much data from every one of them as could be expected. By and by, remote correspondences channels are time differing or recurrence particular particularly for broadband and portable applications. To address these difficulties, a promising blend has been abused, specifically, MIMO with Orthogonal Frequency Division Multiplexing (OFDM), MIMO-OFDM, which has effectively been embraced for present and future broadband correspondence guidelines like LTE or Wi-Max. OFDM can lessen the impact of recurrence specific channel. This is because OFDM is a multi transporter transmission procedure, that partitions the accessible range into numerous transporters, everyone being balanced by a low-rate information stream. One famous blend of MIMO and OFDM is the STBC-OFDM. STBC coding is applied across various OFDM squares to upgrade the framework

OFDM SYSTEM: OFDM System Design OFDM System configuration includes loads of tradeoffs and varying necessities. The ensuing boundaries could be a piece of an overall OFDM framework necessity: (Bittner et al., 2008):

- Data Rate
- Available Bandwidth
- BER
- Delay spread of the channel

Execution of OFDM System The OFDM framework is carried out by joining the distinctive square as demonstrated in Figure 1.1. An OFDM is a Multicarrier Modulation Technique that utilization a cover signs to isolate the recurrence specific channel into various thin band level blurring channel. The FFT encodes the square of the image; rather than sending the information successively on a solitary transporter at a high image rate. The sub-channels are made symmetrical by separating the subcarrier at the expansion of image time. The multipath blurring can be invalidated by making the image time of sub-divert longer in their length as contrast with multipath defer spread. The signs having high clamour and impedance is deactivated, in this way diminishing the impact of blurring and obstruction. OFDM tweak strategy is produced using complex sign handling approaches like Fast Fourier Transforms (FFTs) and backwards FFTs in the transmitter and beneficiary segments of the radio. One of the advantages of OFDM is its solidarity in battling the unfriendly impacts of multipath spread as for between image obstruction in a channel. OFDM is additionally frightfully proficient because the channels are covered and bordering. The square outline of OFDM has appeared in the above figure. In this framework, input information is FEC coded with the method, for example, convolution code.

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

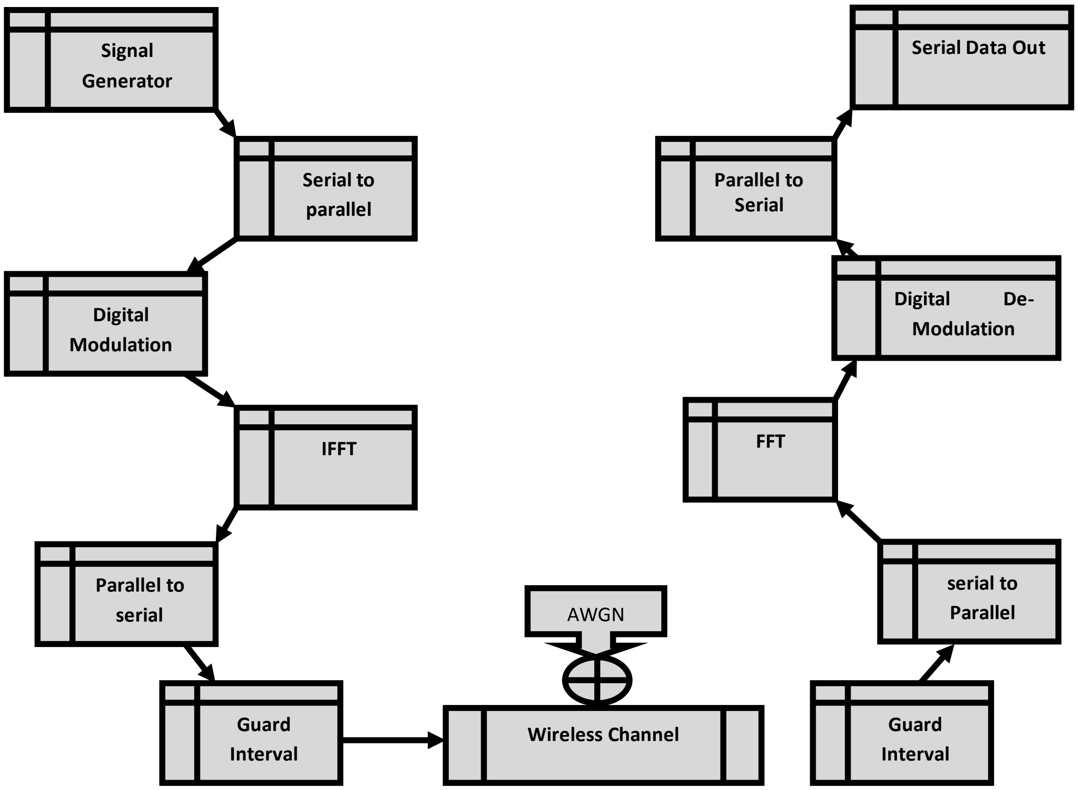

Figure 1 OFDM system Flow diagram

The variety acquire is gotten by interleaving the coded bitstream. The heavenly body focuses are map after a gathering of channel pieces are assembled. Presently the information is sequential which is addressed by complex numbers. Now Mapping Technique, for example, pilot planned is utilized. A sequential to resemble converter is utilized and IFFT is applied on the mind-boggling equal information, according to the need of transmission sub-transporters, the changed information is gathered. In each square of information cyclic prefix is embedded and the information is multiplexed in a sequential style. Presently the OFDM information is balanced and the computerized information is changed over into simple by utilizing a

SYSTEM MODEL: We consider a numerous radio wire remote correspondence framework that is furnished with 2Tx-1Rx and 2Tx-2Rx reception apparatuses. The parallel info information stream is first balanced and planned to a grouping of balance images. The adjusted grouping is then gone through a sequential to-resemble converter. The Alamouti plot is then applied across two continuous OFDM images. As per this coding plan, the signed duplicate isn't just sent from another radio wire yet additionally at some other point. At a given image period, two signs are all the while sent from the two receiving wires. In the first scheduled opening, The sign sent from receiving wire initially is indicated by Xk and from the reception apparatus second by X_{k+1}.

Table 1: Alamouti STBC Scheme

	Antenna 1	Antenna 2
Time t	X_k	X_{k+1}
Time t+T	$-X_{k+1}{}^*$	X_{k^*}

During the next time slot the signal $-X_{k+1}{}^*$is transmitted from the antenna first, and signal X_{k^*} is sent from reception apparatus second where (*) is the mind-boggling form activity as demonstrated in table 1.1. So for two send radio wire, Channel is steady during transmission for double-cross spaces An Inverse quick Fourier Transform (IFFT) is performed on each equal information stream. To figure out the comparing time waveform a converse quick Fourier change is utilized. After the IFFT activity, the got images are added with a cyclic prefix to eliminate the ISI issue yet on this stage the OFDM image have a high top in each OFDM image it increment the PAPR (top to average force proportion) this PAPR make an issue when the sign pass through the HPA(high power enhancer) the commotion because of HPA diminish the sign strength and make the sign degenerate to conquer this difficult we utilize the PAPR decrease procedure here we utilize a cut-out strategy in this postulation to beat this issue. in which we cut the sign sufficiency to the normal level so when the sign goes through the HPA, the clamour from HPA can't expand the sign adequacy from it,s normal worth and it declines the PAPR esteem. The sign is then exchange to the channel the channel have a consistent incentive for both the time allotment .after that sign arrive at the beneficiary through the multipath channel with AWGN clamors.

MIMO STBC OFDM SYSTEM WITH CLIPPING : In the MIMO STBC OFDM system with clipping technique, the OFDM symbol on the Kth carrier and the i^{th} antenna is as follows

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Journal homepage: www.ijrpr.com ISSN 2582-7421

$$x_k^l = \sum_{i=0}^{N-1} x_i e^{2\pi \frac{i}{N} k}$$

Where x_i is data symbol for ith subcarrier, each $x^l{}_k$ make a square of OFDM image of lth receiving wire where k = 0 to N-1 and we use N transporter so the length of OFDM image N times the time of single information image, after this cut-out method measure is as follows

$$x_k^l(\text{clip}) = \text{avg value} \text{ , if } x_k^l > \text{avg value}$$
$$x_k^l(\text{clip}) = -\text{avg value} \text{ , if } x_k^l < -\text{avg value}$$

Non-linear HPA effect on OFDM symbol in without clipping technique

$$if \;\; x_k^l > avg\ value$$
$$x_k^l = x_k^l + \text{noise}$$
$$if \;\; x_k^l < -avg\ value$$
$$x_k^l = x_k^l + \text{noise}$$

Non-linear HPA effect on framed OFDM symbol in clipping technique

$$if \;\; x_k^l(\text{clip}) > avg\ value$$
$$x_k^l(\text{clip}) = x_k^l(\text{clip}) + \text{noise}$$
$$if \;\; x_k^l(\text{clip}) < -avg\ value$$
$$x_k^l(\text{clip}) = x_k^l(\text{clip}) + \text{noise}$$

MIMO STBC OFDM 2TX 1RX ANTENNA WITH CLIPPING: When 2Tx and 1Rx antenna are considered, to send the data first we divide the data into k=0 to N-1 segment, each segment consist 0 to N-1 data symbol and the STBC encoding algorithm on each segment is as follows.

Table 2: Alamouti STBC Scheme for 2x1 Tx/Rx Configuration

	t_1	t_1+T
T_{x1}	X_k	$-X_{k+1}$*
T_{x2}	X_{k+1}	X_k*

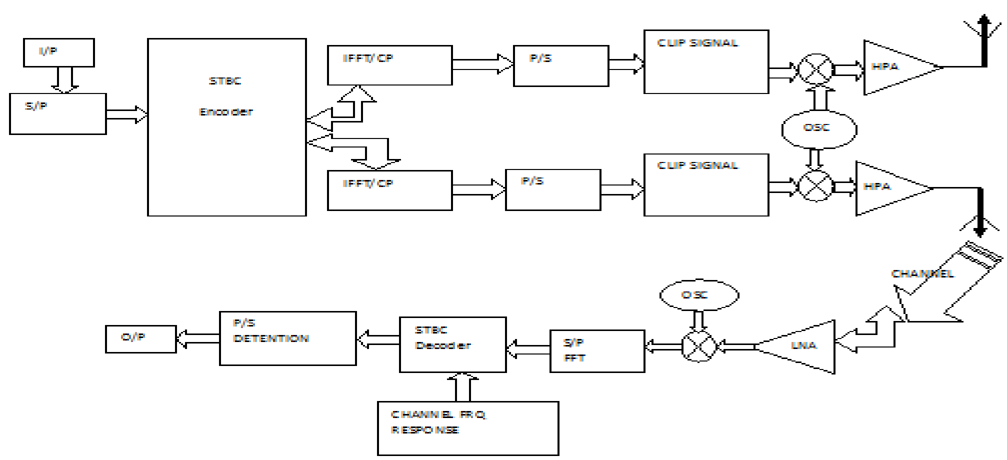

Figure 2: MIMO STBC OFDM 2Tx 1Rx Transceiver with clipping

After this STBC encoding, we send each encodes information section to the IFFT where it converts the signal into time area signal after IFFT $x0,x1,x2,\ldots$ $.xN-1$ is OFDM image for each portion and these all OFDM image make a square of first OFDM image that length is NTs currently convert these equal OFDM image to the sequential this OFDM image after cutting ship off the transmitter. The square of the OFDM image communicate from the receiving wire as follows

T_{x1} = [$-X_1* \;\; X_2 \;\; -X_3*\ldots\ldots X_{N-1}$]

T_{x2} = [$X_0* \;\; X_3 \;\; X_2* \ldots\ldots X_{N-1}$]

$X_0, X_1, X_2, X_3, \ldots\ldots,_{-1}$ is the block of OFDM symbol

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Journal homepage: www.ijrpr.com ISSN 2582-7421

At the receiver side, the received signal at the receiving antenna R_{x1} is as follows. Where H_{11} and H_{12} channel response for T_{x1} and T_{x2} and N is the AWGN noise of the channel.

R=HX+N

$$R = \begin{bmatrix} R_{t1} \\ R^*_{t1+T} \end{bmatrix} = \begin{bmatrix} H_{11} & H_{12} \\ H^*_{12} & -H^*_{11} \end{bmatrix} \begin{bmatrix} X_k \\ X_{k+1} \end{bmatrix} + \begin{bmatrix} N_k \\ N^*{}_{k+1} \end{bmatrix}$$

To decode the signal on the receiver side first we compute the channel frequency response $H11$ and $H12$ .then we use the ZF equalizer to decode the OFDM data as follows.

The decoding algorithm is as follows.

$$R^\wedge = \begin{bmatrix} R^\wedge{}_{t1} \\ R^\wedge{}_{t1+T} \end{bmatrix} = H^H R = \begin{bmatrix} H^*_{11} & H_{12} \\ H^*_{12} & -H_{11} \end{bmatrix} \begin{bmatrix} R_{t1} \\ R^*{}_{t1+T} \end{bmatrix}$$

$$\begin{bmatrix} H^2{}_{11} + H^2{}_{12} & 0 \\ 0 & H^2{}_{12} + H^2{}_{11} \end{bmatrix} \begin{bmatrix} X_k \\ X_{k+1} \end{bmatrix} + \begin{bmatrix} N_1\sim \\ N_2\sim \end{bmatrix}$$

Where H^H means the conjugate transpose of H

$$\begin{bmatrix} N_1\sim \\ N_2\sim \end{bmatrix} = \begin{bmatrix} H^*_{11} & H_{12} \\ H^*_{12} & -H_{11} \end{bmatrix} \begin{bmatrix} N_k \\ N^*{}_{k+1} \end{bmatrix}$$

MIMO STBC OFDM 2Tx 2Rx ANTENNA WITH CLIPPING: When 2Tx-2Rx antenna system is considered, assuming the channel response for Rx1 is H_{11}, H_{12} and for Rx2 is H_{21}, H_{22} respectively

The received signal in the time domain is as follows.

$$R = \begin{bmatrix} R^1{}_{t1} \\ R^1{}_{t1+T} \\ R^2_{t1} \\ R^2_{t1+T} \end{bmatrix} = \begin{bmatrix} H_{11} & H_{12} \\ H^*_{12} & -H^*_{11} \\ H_{21} & H_{22} \\ H^*_{22} & -H^*_{21} \end{bmatrix} \begin{bmatrix} X_k \\ X_{k+1} \end{bmatrix} + \begin{bmatrix} N^1{}_k \\ N^{1*}{}_k \\ N^2{}_k \\ N^{2*}{}_{k+1} \end{bmatrix}$$

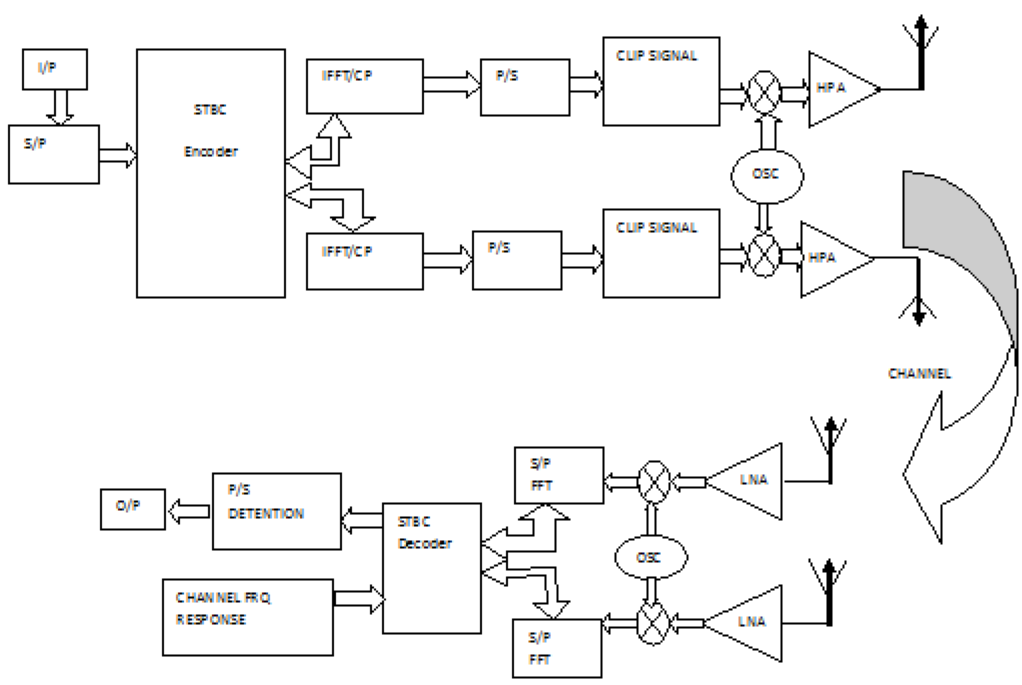

Figure 3: MIMO STBC OFDM 2Tx 2Rx Transceiver with clipping

Suppose two adjacent times have the same channel response then

$H^{11}{}_t=H^{11}{}_{t+T}$, $H^{12}{}_t=H^{12}{}_{t+}$, $H^{21}{}_t=H^{21}{}_{t+T}$, $H^{22}{}_t=H^{22}{}_{t+T}$

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Journal homepage: www.ijrpr.com ISSN 2582-7421

The decoding algorithm is as follows

$$R^\wedge = \begin{bmatrix} R^\wedge{}_{t1} \\ R^\wedge{}_{t1+T} \end{bmatrix} = H^H R = \begin{bmatrix} H_{11}^* & H_{12} & H_{21}^* & H_{22} \\ H_{12}^* & -H_{11} & H_{22}^* & -H_{21} \end{bmatrix} \begin{bmatrix} R^1{}_{t1} \\ R^{1*}{}_{t1+T} \\ R^2{}_{t1} \\ R^{2*}{}_{t1+T} \end{bmatrix}$$

$$\begin{bmatrix} H^2{}_{11} + H^2{}_{12} & H^2{}_{21} + H^2{}_{22} \end{bmatrix} \begin{bmatrix} X_k \\ X_{k+1} \end{bmatrix} + \begin{bmatrix} N_1\sim \\ N_2\sim \end{bmatrix}$$

$$\begin{bmatrix} N_1\sim \\ N_2\sim \end{bmatrix} = \begin{bmatrix} H_{11}^* & H_{12} & H_{21}^* & H_{22} \\ H_{12}^* & -H_{11} & H_{22}^* & -H_{21} \end{bmatrix} \begin{bmatrix} N^1{}_{t1} \\ N^{1*}{}_{t1+T} \\ N^2{}_{t1} \\ N^{2*}{}_{t1+T} \end{bmatrix}$$

II. LITERATURE WORK

Table 3 Literature Summary

Author /Journal /Year	Work	Outcome
M Naumenko et al [1]/ Problems of Info-communications. Science and Technology, IEEE 2019	A Space-Time Block Coding (STBC) with Dual-Mode Index Modulation Aided OFDM (DM-OFDM-IM) scheme is proposed for enhancing the Bit Error Rate performance and Spectral Efficiency.	For 14 dB noise and 9 dB IBO, Estimated phase values are 10 and variance is 0.90, For 14 dB noise and 20 dB IBO Estimated phase values are 0.8 and variance is 0.06 For 20 dB noise and 9 dB IBO Estimated phase values is 9.2 and variance is 0.43, For 20 dB noise and 20 dB IBO Estimated phase values is 0.8 and variance is 0.02.
R tang et al [2]/ IEEE Access 2020	Kalman filter (KF) based channel estimation method applied to 2X2 and 4X4 STBC MIMO-OFDM systems. A new orthogonal space-time codeword is adopted, and the orthogonal pilot sequences are designed to suppress the interference among transmit antennas.	For 0 dB noise SER obtain is 10^{-1}, For 6 dB noise SER obtain is 10^{-2}, For 12 dB noise SER obtain is 10^{-3}, For 20 dB noise SER obtain is $0.5x10^{-5}$
F Rocha [1]/IEEE proceedings 2017	implementation of a 4x4 MIMO system, using universal software-defined radio peripherals, with Alamouti and QSTBC codes. employed FEC and M-QAM modulation to increase the transmission reliability at high bit rates	For 16QAM and 0 dB noise BER obtain is 0.119126, For 10 dB noise BER obtain is 0.046518, For 20 dB noise BER obtain is 0.026293, For 30 dB noise BER obtain is 0.023592

Numerous information different yield (MIMO) frameworks, as a rule, while working with nonlinear HPAs further cause nonlinear between channel obstruction (ICI) [7]. In particular, for numerous info, different yield space-time block code (MIMO-STBC) frameworks, the HPA's nonlinearity with stage change impact, turns the get signal and obliterates symmetry of the code. Along these lines, proficient countermeasures are needed for lessening such negative impacts in such frameworks.

Bending pay at beneficiary is one out of the traditional techniques for countering with nonlinear contortion [6]. Among this arrangement bunch, a straightforward yet proficient technique is the ideal extra stage move (OAPS) [8] at first proposed for SISO frameworks and presently created for MIMO-STBC frameworks [9]. Essentially, in these works, a boundary for the most part describing the nonlinearity called distance debasement dd is utilized to decide the ideal pay stage for derogating the get star grouping that was turned under nonlinear impact. Along these lines, this dd boundary should be known as recipient. Further, OAPS esteems are just determined at a few explicit piece blunder proportions (BER), for instance at 10−3 or 10−6. Ideal feed-forward daze symphonious and biharmonic stage assessment strategies were proposed for standard straight SISO M-QAM frameworks with obscure fixed stage turn [10], [11]. This plan is known as an effective assessor moving toward the lower Cramer-Rao bound [11], [12]. Notwithstanding, at the best of our insight, there is no comparative stage assessor proposed for the nonlinear MIMO-STBC frameworks.

Fr

anklin Rocha et al [3] work with 2x1 alamouti symmetrical plan for the decrease in non-direct contortion yet 2x1 symmetry conspire is moderate and can send just two images equal. Ruiguang tang et al [2] was utilizing neural organization for a decrease of non-direct commotion contortion in HPA however neural organization requires heaps of memory and time for calculation. Mykola Naumenko et al [1] use STBC plot for removal of non-straight twisting of HPA their work great when channel side data accessible however channel side data not accessible their techniques comes up short.

III. PROPOSED METHODOLOGY

For the consummation of proposed work equipment and programming, prerequisite are as follow:-

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Journal homepage: www.ijrpr.com ISSN 2582-7421

Equipment Requirement: any equipment that helps MATLAB can be utilized commonly a universally useful PC framework or a PC however we can likewise utilize a little PC framework which elite has MATLAB programming just like Raspberry-pi and so on or in not so distant future a little regulator which has MATLAB Mathematical tool compartment just can be created because proposed work requires just numerical tool compartment of MATLAB.
Programming Requirement: Software needed for the fruition of proposed work is MATLAB any form, particularly requires MATLAB numerical Toolbox, OS can be Window or Linux where MATLAB can introduce, SCILAB and LABVIEW likewise can be utilized for proposed work.
ORTHOGONALITY in MIMO: To achieve rate-1 to lot than two antennas in data communication, rate means ratio in-between number of symbols transmitted & time slots figure below modals four antennas & four symbols (A, B, C, D) & it may be seen it uses four-time slots (T1, T2, T3, T4) to transmit, if presented work possibly arrange these symbols in an orthogonal way to only four-time slots & four antennas then it will be full rate (rate-1) transmission with a very less fading..
In addressing the problem of decoding complexity, STBC may efficiently achieve transmit diversity to combat fading. By using orthogonality of transmitted symbols, Alamouti [6] first defined a space-time transmission matrix as:

$$A_{12} = \begin{bmatrix} x_1 & x_2 \\ -x_2^* & x_1^* \end{bmatrix}$$

W

here subscript 12 indicates indeterminate & available in the transmission matrix. Based on Alamouti orthogonal STBC, Mykola Naumenko [1] gave a quasi-orthogonal STBC form to four transmit antennas as:

$$C_S = \begin{bmatrix} X_1 & X_2 & X_3 & X_4 \\ X_2 & -X_1^* & -X_4 & X_3^* \\ X_3 & X_4^* & -X_1 & -X_2^* \\ X_4 & -X_3^* & X_2 & -X_1^* \end{bmatrix}$$

W

here A is Alamouti codes. Its character matrix is similar fashion as sparse matrix pattern, & presented work may write it as:

$$C_s^H C_s = \begin{bmatrix} a & 0 & 0 & b_s \\ 0 & a & -b_s & 0 \\ 0 & b_s & a & 0 \\ b_s & 0 & 0 & a \end{bmatrix}$$

W

here C^H is Hermitian of matrix C, a $=\sum_{i=1}^{4} x_i^2$, & correlated value is $b_S = (x_1 x_4^* + x_1^* x_4) - (x_2 x_3^* + x_3^* x_2)$ a real number. previously, R Tang et al [2] has

$$C_B = \begin{bmatrix} X_1 & X_2 & X_3 & X_4 \\ -X_2 & X_1 & -X_4 & X_3 \\ -X_3 & X_4 & X_1 & -X_2 \\ -X_4 & -X_3 & X_2 & X_1 \end{bmatrix}$$

$$C_B^H C_B = \begin{bmatrix} a & 0 & b_B & 0 \\ 0 & a & 0 & b_B \\ b_B & 0 & a & 0 \\ 0 & b_B & 0 & a \end{bmatrix}$$

Where correlated value. $b_B = x_1 x_3^* + x_1^* x_3 + x_2 x_4^* + x_4^* x_2$ In this letter, the presented work present couple of new outlines through breaking down character systems of available plans. Also, one of the new outlines may enhance renderings by lessening obstructions of nearby images
Utilizing a unitary example thought base paper to research the conveyance of conjugates in transmission grids, they find that it is identified with places of connected qualities. By changing the dispersion of conjugates, presented work may get systems with various places of connected qualities.

Franklin Rocha et. al. [3] presented fading Encoder Matrix

$$C_K^H = \begin{bmatrix} X_1 & X_2 & X_3 & X_4 \\ -X_2^* & X_1^* & -X_4^* & X_3^* \\ X_3 & X_4 & -X_1 & -X_2 \\ -X_4^* & X_3^* & X_2^* & -X_1^* \end{bmatrix}$$

$$C_{JT}^H C_{JT} = \begin{bmatrix} a & 0 & b_K & 0 \\ 0 & a & 0 & -b_K \\ b_K & 0 & a & 0 \\ 0 & b_K & 0 & a \end{bmatrix}$$

Thanh Nguyen et al [2] presented fading Encoder Matrix

$$C_A^H = \begin{bmatrix} X_1 & X_2 & X_3 & X_4 \\ X_2^* & -X_1^* & X_4^* & -X_3^* \\ X_3 & X_4 & X_1 & X_2 \\ -X_4^* & X_3^* & -X_2^* & -X_1^* \end{bmatrix}$$

Thus presented work obtain character matrix as:

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$$C_A^H C_A = \begin{bmatrix} a & 0 & 0 & b_A \\ 0 & a & b_A & 0 \\ 0 & b_a & a & 0 \\ b_A & 0 & 0 & a \end{bmatrix}$$

Where b_A = bs & positions of correlated values are the same as Mykola Naumenko [1] case. Similar to the above analysis, the presented work has $\lambda_B = \lambda_A$, because

$$\det(B_B^H B_B) = \det(B_A^H B_A)$$

By utilizing MRC interpreting calculation, these two cases introduce comparative renderings, & reenactments appear in Fig. 3.1. In this way, summing up to over two changed cases, various circulations of conjugates in transmission grid may prompt to various places of connected qualities & places of associated values in character network are not specifically comparing to renderings of semi-orthogonal STBC.

PRESENTED NEW MATRICES DESIGNS WITH NEW POSITIONS OF CORRELATED VALUES : As per the above investigation, the presented work knows places of corresponded qualities don't influence BER. In this way, the presented work determines a couple of new networks with various places of corresponded qualities from the dissemination of conjugates in the base of transmission grids. At that point presented work has outlined a new frame as:

ST

BC may proficiently accomplish transmit assorted qualities to battle blurring. By utilizing orthogonality of transmitted images, Alamouti initially characterized a space-time transmission system as:

$$A_{12} = \begin{bmatrix} X_1 & X_2 \\ -X_2^* & X_1^* \end{bmatrix}$$

Based on Alamouti orthogonal STBC presented gave a quasi-orthogonal STBC form to four transmit antennas as:

$$C_{ND} = \begin{bmatrix} A_{12} & A_{34} \\ -A_{34}^* & A_{12}^* \end{bmatrix} = \begin{bmatrix} X_1 & X_2 & X_3 & X_4 \\ -X_2^* & X_1^* & -X_4^* & X_3^* \\ -X_3^* & -X_4^* & X_1^* & X_2^* \\ X_4 & -X_3 & -X_2 & X_1 \end{bmatrix}$$

Its character matrix is similar fashion as sparse matrix pattern, & presented work may write it as:

$$C_{ND}^H C_{ND} = \begin{bmatrix} a & 0 & 0 & B_{ND} \\ 0 & a & -B_{ND} & 0 \\ 0 & -B_{ND} & a & 0 \\ B_{ND} & 0 & 0 & a \end{bmatrix}$$

Where C^H is Hermitian of matrix C, $a=\sum_{i=1}^{4} x_i^2$, & correlated value is $b_{ND} = (x_1 x_4^* + x_1^* x_4) - (x_2 x_3^* + x_3^* x_2)$ a real number, & it is lesser compare with available QSTBC methods to reduce BER. Rendering to new mentioned matrices gives better result when compared with available above-mentioned matrices. & also on basis of the above-mentioned matrix presented work has calculated BER to various PSK systems.

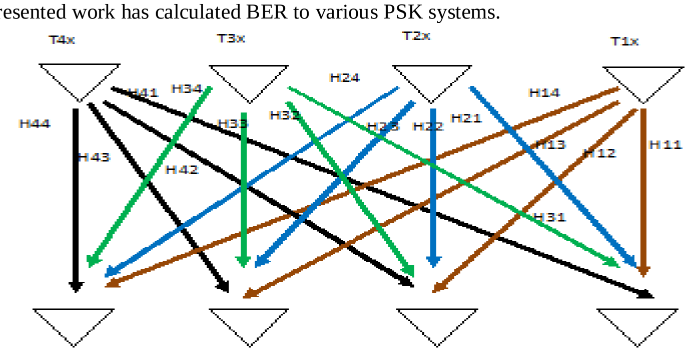

Figure 4: Channel definition in 4Tx 4Rx diversity scheme

When the 4Tx-4Rx antenna system is considered, assuming the channel response for Rx1 is H_{11}, H_{12}, H_{13}, H_{14} and for Rx2 is H_{21}, H_{22}, H_{23}, H_{24} and for Rx3 is H_{31}, H_{32}, H_{33}, H_{34} respectively.

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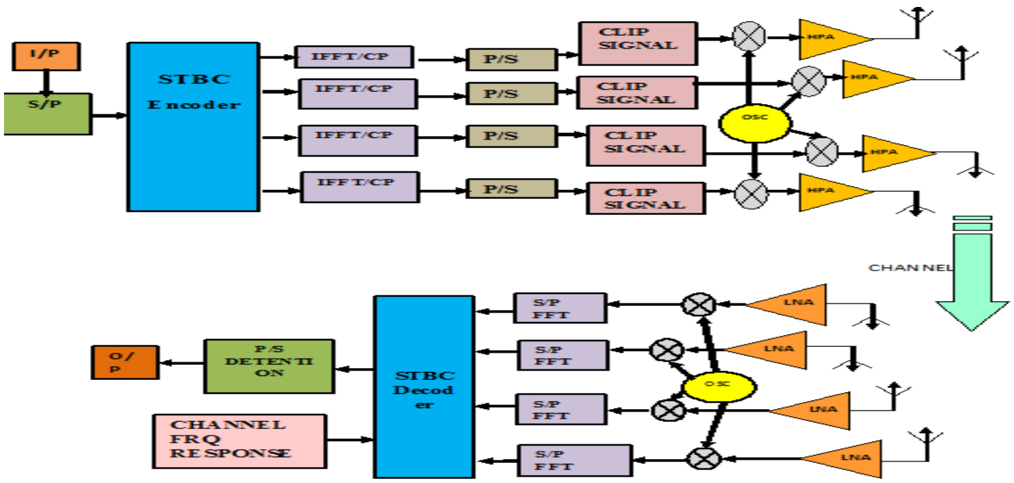

Figure 5: MIMO STBC OFDM 4Tx 4Rx Transceiver with clipping

The received signal in the time domain is as follows.

$$R = \begin{bmatrix} R^1{}_{t1} \\ R^1{}_{t1+T} \\ R^2_{t1} \\ R^2_{t1+T} \end{bmatrix} = \begin{bmatrix} H_{11} & H_{12} \\ H^*_{12} & -H^*_{11} \\ H_{21} & H_{22} \\ H^*_{22} & -H^*_{21} \end{bmatrix} \begin{bmatrix} X_k \\ X_{k+1} \end{bmatrix} + \begin{bmatrix} N^1{}_k \\ N^{1*}{}_k \\ N^2{}_k \\ N^{2*}{}_{k+1} \end{bmatrix}$$

Suppose two adjacent times have the same channel response then
$H^{11}{}_t=H^{11}{}_{t+T}$, $H^{12}{}_t=H^{12}{}_{t+}$, $H^{21}{}_t=H^{21}{}_{t+T}$, $H^{22}{}_t=H^{22}{}_{t+T}$
The decoding algorithm is as follows

$$R\wedge = \begin{bmatrix} R\wedge_{t1} \\ R\wedge_{t1+T} \end{bmatrix} = H^H R = \begin{bmatrix} H^*_{11} & H_{12} & H^*_{21} & H_{22} \\ H^*_{12} & -H_{11} & H^*_{22} & -H_{21} \end{bmatrix} \begin{bmatrix} R^1{}_{t1} \\ R^{1*}{}_{t1+T} \\ R^2{}_{t1} \\ R^{2*}{}_{t1+T} \end{bmatrix}$$

$$\begin{bmatrix} H^2{}_{11} + H^2{}_{12} & H^2{}_{21} + H^2{}_{22} \end{bmatrix} \begin{bmatrix} X_k \\ X_{k+1} \end{bmatrix} + \begin{bmatrix} N_1\sim \\ N_2\sim \end{bmatrix}$$

$$\begin{bmatrix} N_1\sim \\ N_2\sim \end{bmatrix} = \begin{bmatrix} H^*_{11} & H_{12} & H^*_{21} & H_{22} \\ H^*_{12} & -H_{11} & H^*_{22} & -H_{21} \end{bmatrix} \begin{bmatrix} N^1{}_{t1} \\ N^{1*}{}_{t1+T} \\ N^2{}_{t1} \\ N^{2*}{}_{t1+T} \end{bmatrix}$$

IV. RESULTS

The following parameters have been taken to the simulation of the presented model. The result of the BER study with 2, 4 & 16 PSK modulations using the presented model is modern below in further sections.

- *System Model = STBC*
- *No. of Transmitting Antennas = 1, 2, 3, 4*
- *No. of Receiving Antennas = 1, 2, 3, 4*
- *Primary Modulation = 2, 4 & 16 PSK*
- *Noise = 0, 3, 6………21 db*
- *No. of samples = 500 samples*
- *No. of symbols in a signal= 200 symbols*
- *Sampling Frequency = 1/500*
- *Signal Frequency = 1*
- *Signal = Random Integer Signal*
- *Noise = Random Noise & Additive White Gaussian Noise (AWGN)*

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Figure 6 below shows the GUI developed for the proposed work, input and output editors and four plot areas can be seen in figure 4.1. In GUI START is the push button for starting the background program (proposed design main code) in MATLAB, Two input editors are the Modulation PSK value (2,4,8,16 or 64) and the second input is the offset in the input signal. in GUI their four editors output first output editor shows the average SNR obtained between the transmitted signal and received signal, Second output editor shows the MSE obtained between the transmitted signal and received signal, third output editor shows the BER obtained between the transmitted signal and received signal and fourth output editor shows the time offset obtained between transmitted HPA amplified signal and received signal.

Figure 6 below shows comparative results observation for the parameter average bit error rate (BER) when the 4-PSK modulation technique is used at the transmitter side and input signal offset is taken 0.5. It can be seen that this work proposed QSTBC encoder used in 4X4 MIMO OFDM has less BER than Mykola Naumenko et al [1] QSTBC encoding scheme, R Tang et al [2] STBC encoding scheme, Franklin Rocha et al [3] OSTBC encoding scheme. Figure 6 below shows comparative results analysis when the input signal is added with different amount of noise (i. e. 0db, 3db,6db......30db) when 4-PSK modulation done. It may be observed from figure 4.3 as the noise amount in the input signal decreases (i.e. 0db to 30db) the Bit error rate is also decreasing in all the designs, also proposed work has less BER than other base works at any amount of noisy input signal

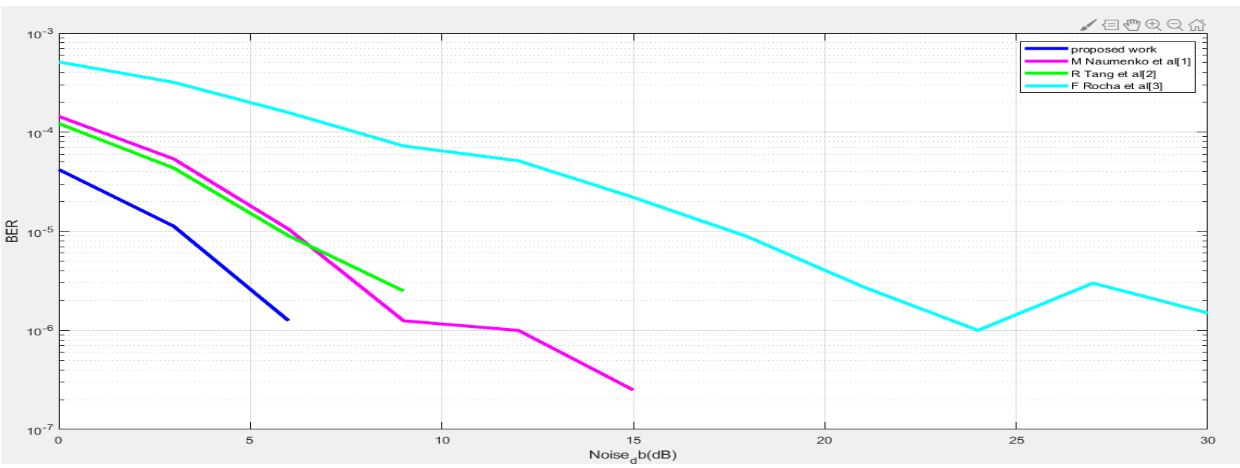

Figure 6: BER comparative analysis for all designs when 4-PSK comparison

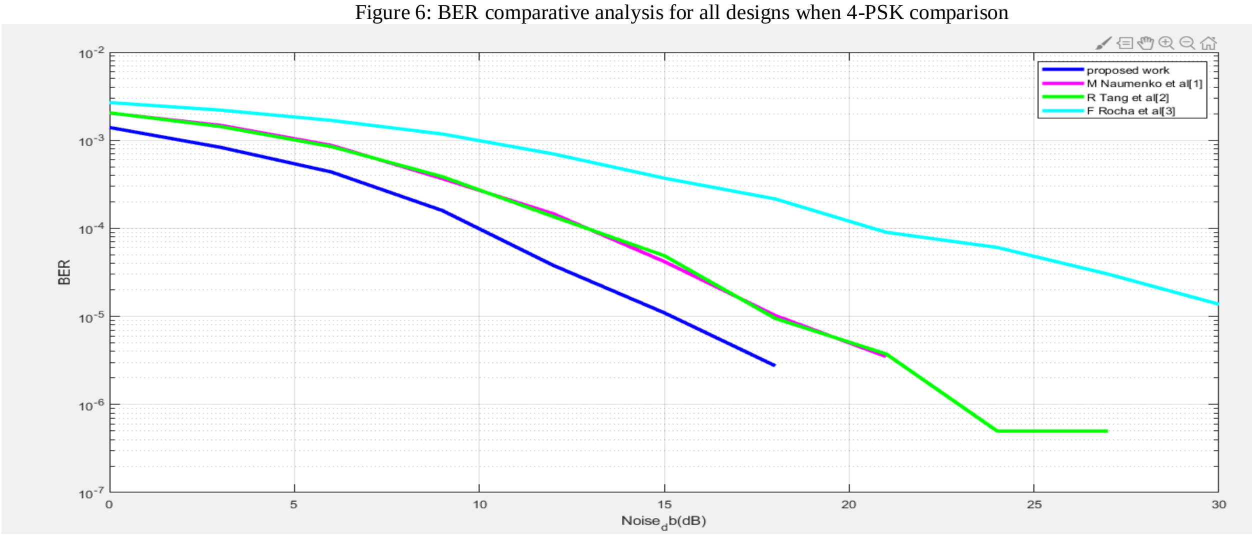

Figure 7: BER comparative analysis for all designs when 16-PSK comparison

Figure 7 below shows comparative results analysis when the input signal is added with different amount of noise (i. e. 0db, 3db,6db......30db) when 16-PSK modulation done, It may be observed from figure 4.6 as the noise amount in the input signal decreases (i.e. 0db to 30db) the Bit error rate is also decreasing in all the designs, also proposed work has less BER than other base works at any amount of noisy input signal

Figure 8 below shows comparative results analysis when the input signal is added with different amount of noise (i. e. 0db, 3db,6db......30db) when 64-PSK modulation done, It may be observed from figure 4.9 as the noise amount in the input signal decreases (i.e. 0db to 30db) the Bit error rate is also decreasing in all the designs, also proposed work has less BER than other base works at any amount of noisy input signal

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

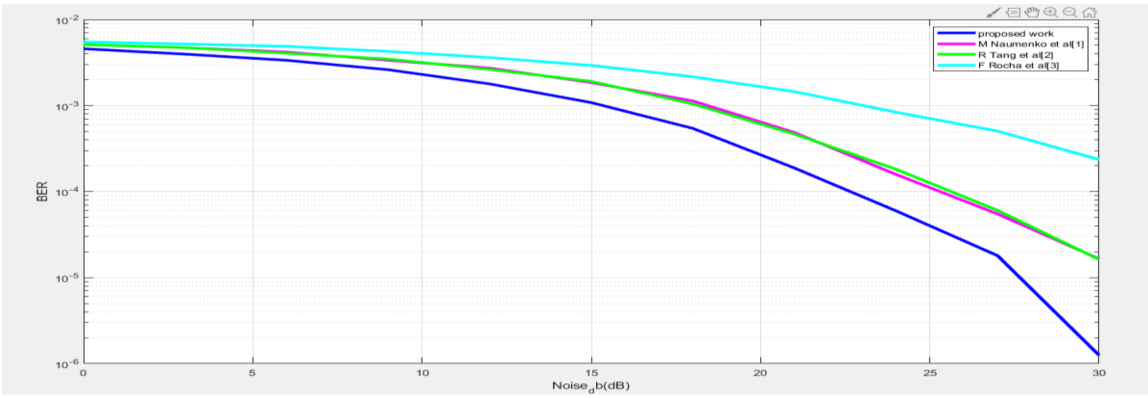

Figure 8 BER comparative analysis for all designs when 64-PSK comparison

Table 4 modals comparative results among all available models. coding is been done to a random input signal & amount of noise is been selected with its dB value range from 0db to 30 dB with a step size of 3db, means first 0db noise will be added into signal & after applying OSTBC, BER is been calculated in-between original signal & signal after decoding using OSTBC & same procedure will be carried out to 3db noise & 6db noise & so on.

Table 4: Comparative results

	Mykola Naumenko et al [1] *10^-3	**R Tang et al [2] *10^-3**	**Franklin Rocha et al [3] *10^-3**	**Proposed work *10^-3**
0	0.4005	0.508250	0.5055	0.13925
3	0.2170	0.2770	0.32025	0.03925
6	0.1155	0.16075	0.16375	0.0080
9	0.05225	0.08675	0.07425	0.00350
12	0.02650	0.0470	0.0490	0.00050
15	0.0130	0.02225	0.02225	0.00025
18	0.01050	0.0120	0.00750	0
21	0.0030	0.00575	0.0010	0

The OSTBC scheme in the presented code Mykola Naumenko et al [1] encoding scheme is less efficient than R Tang et al [2]encoding scheme, Franklin Rocha et al [3] encoding finally to presented encoding method. Signal & amount of noise has been taken the same to encoding techniques.

It may be observed from table-4 that presented work causes very small amount of BER in case to highly noisy signal, in case to less noisy signal it did not generates any BER however all other available models & base paper models did produce BER lot than presented work at any kind of less or highly noisy signal. the presented model uses quasi-orthogonal coding & which gives good results. Also presented work is been designed with a combination of jafarkhani[10] code correlated with base work. It may be said that the presented model is a full rate BER model, full-rate signifies that four symbols will transfer in four-time slots.

Table 5: SNR observed to various BER observations

BER x10^-3	**Mykola Naumenko et al [1]**	**R Tang et al [2]**	**Franklin Rocha et al [3]**	**Presented work**
0.0025	24	15	15	10
0.139	6	6	6	0

It may be observed from table 5 above that SNR observed to propose OSTBC encoder is highest at the various amount of BER. Here first BER is fixed at 0.005 & the SNR amount at that particular BER is observed to all test scenarios of base works& then BER is fixed at 0.0025 & then at 0.0045 & results are observed. It may be observed from the figure above that SNR in presented work is highest at any BER data & is better than base paperwork & with all four standard cases.

V.CONCLUSION

The presented work Design of the QSTBC encoder for the 4x4 OFDM system resolve the nonlinear phase shift in HPA in MIMO-OFDM, it can be concluded that the methods available are good enough but also need to improve the automatic phase Compensation method with good throughput and less BER. The presented thesis provides a review of automatic phase Compensation methods used in 4x4 MIMO, thesis also discusses the problem of non-linear phase shift high power amplifier due to and the solutions provided by different authors.

To reduce decoding delay using the recently introduced Space Frequency Block Coding (SFBC) technique which is an extension to space-frequency transmitter diversity technique introduced by Lee & Williams. presented work has inferred vital & adequate conditions so that an STBC is multi-bunch decodable.

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Journal homepage: www.ijrpr.com ISSN 2582-7421

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