# Review of PAPR Reduction for MIMO-OFDM Systems in 5G Communication System

Ankit Lodi<sup>1</sup>, Dr. Mukul Shrivastav<sup>2</sup>

M. Tech. Scholar, Department of Electronics and Communication, LNCTE, Bhopal<sup>1</sup>

Head of Department, Department of Electronics and Communication, LNCTE, Bhopal<sup>2</sup>

## ABSTRACT

In recent time, the demand for multimedia data services has grown up rapidly. One of the most promising multi-carrier system, Orthogonal Frequency Division Multiplexing (OFDM) forms basis for all 5G wireless communication systems due to its large capacity to allow the number of subcarriers, high data rate and ubiquitous coverage with high mobility. OFDM is significantly affected peak-to-average-power bv ratio (PAPR). Unfortunately, the high PAPR inherent to OFDM signal envelopes will occasionally drive high power amplifiers (HPAs) to operate in the nonlinear region of their characteristic curve. This paper emphasis mainly on the PAPR reduction of MIMO-OFDM system using partial transmits sequence (PTS) and pre-coding techniques. Some other techniques such as amplitude clipping have low-complexity; on the other hand, they suffer from various problems such as in-band distortion and out-of-band expansion. Signal companding methods have low-complexity, good distortion and spectral properties; however, they have limited PAPR reduction capabilities. Advanced techniques such as coding, partial transmit sequences (PTS) and selected mapping (SLM), have also been considered for PAPR reduction.

Keywords—PTS, STBC, MIMO, OFDM, PAPR.

## **INTRODUCTION**

This work will be used as Potential reference in nature and will aim to provide a basic understanding of OFDM as a candidate technology for 5G systems. It presents detailed performance results for OFDM with different modulation techniques, under different channel conditions and finally provides a comparison with an OFDM based communication system. Since 1980 when first generation system was introduced and till now there is seen a rapid growth in the field of communication and mobile technology. In Wireless Technology there has been subtle increases in peak bit rate in previous generations (0G to 4G). With every passing decade, the mobile generation is changing and as the current generation is 4G introduced in early 2010. The year 2020 is said to be the year for the fifth generation (5G) systems which is smarter and sophisticated technology.

Fifth generation (5G) innovation is intended to give staggering and wonderful information capacities, unhindered call volumes, and unlimited information communicate inside the most recent versatile working framework. Thus, it is more astute innovation, which will interconnect the whole world unbounded. 5G will give a nonexclusive way to deal with make organize performs considerably more adaptable and all inclusive, keeping in mind the end goal to adapt to



International Journal of Innovative Research in Technology and Management (IJIRTM), Volume-3, Issue-2, 2019 ISSN: 2581-3404 (Online)

metropolitan

heterogeneous conditions and necessities. It will execute merging amongst settled and versatile systems administration administrations with the related systems.

OFDM has been proposed as a transmission technique to bolster rapid information transmission over remote connections in multipath situations. Amid the most recent forty years, OFDM has formed into a famous plan for wideband advanced correspondence, whether remote or over wires, utilized as a part of uses, for example, computerized TV and sound television, remote systems administration and broadband web access [6]. OFDM system also utilized digital-to-analog converters (DAC) and analog-to-digital converters (ADC) in its signal processing loop. To help high PAPR, a high accuracy DAC and ADC are required, which is exceptionally costly for a given examining rate of the framework. While, a lowexactness DAC and ADC would be less expensive, yet its quantization commotion will be noteworthy, and therefore it diminishes the SNR when the dynamic scope of DAC and ADC increments to help high PAPR. Along these lines, the PAPR diminishment is basic for an OFDM framework for accomplishing better power effectiveness, huge territory scope and low BER. Most of the wireless communication systems employed high power amplifier (HPA) at the output of transmitter to obtain sufficient transmits power for large area coverage. For achieving maximum power efficiency, the HPA is usually operated at or near the saturation region. When high peak power signal pass through such HPA, peaks are clipped non-linearly and inter-modulation distortion are induced at the output. This additional interference leads to an increase in BER.

MIMO has been developed for many years for wireless systems. One of the earliest MIMO to wireless communications applications came in mid-1980 with the breakthrough developments. . Since then, several academics and engineers have made significant contributions in the field of MIMO. Now MIMO technology has aroused interest because of its possible applications in digital television, wireless local area networks,

increases the channel capacity, which is in proportional to the total number of transmitter and receiver arrays. Second, MIMO system provides the advantage of spatial variety: each one transmitting signal is detected by the whole detector array, which not only improved system robustness and reliability, but also reduces the impact of Inter symbol interference (ISI) and the channel fading.
 **II LITERATURE REVIEW** Owing to the signal structure difference between the filter bank multicarrier with offset quadrature area in the signal structure (ISI) and the signal structure difference between the filter bank multicarrier with offset quadrature

area

networks

communication. First, MIMO system greatly

and

mobile

the filter bank multicarrier with offset quadrature amplitude modulation (FBMC/OQAM) and the frequency-division multiplexing orthogonal (OFDM) systems, the existing technologies to reduce the peak-to-average power ratio (PAPR) for OFDM systems are not suitable for the FBMC/OQAM systems. The main idea of this joint optimization scheme is clipping and filtering the processed FBMC/OQAM signal, whose probability of the peak value has been reduced by the IBPTS technique. Meanwhile, aided by the knowledge of convex optimization, the IBPTS-ICF joint optimization scheme can effectively reduce the signal distortion. The excellent PAPR reduction performance of the proposed scheme has been confirmed in our simulations by Junhui Zhao et al. [1].

The implementation of MIMO with OFDM is an effective and more attractive technique for high data rate transmission and provides burly reliability in wireless communication. It has lot of advantages which can decrease receiver complexity, provides heftiness against narrowband interference and have capability to reduce multipath fading. The major problem of MIMO-OFDM is high PAPR which leads to reduction in Signal to Quantization Noise Ratio of the converters which also degrades the efficiency of power amplifier at transmitter. In this paper we mainly focus on one of scrambling and nonscrambling technique Iterative clipping and filtering, and partial Transmit sequence (PTS) which results in better performance. The two



International Journal of Innovative Research in Technology and Management (IJIRTM), Volume-3, Issue-2, 2019 ISSN: 2581-3404 (Online)

techniques once united or combined in the system prove that along with trimming down the PAPR value, the power spectral density also gets smoother by Ashna Kakkar et al. [2].

A combination of multiple-input multiple output (MIMO) signal processing with orthogonal frequency division multiplexing (OFDM) is regarded as a promising solution for enhancing the performance of next generation wireless local area network (WLAN) systems. However, like OFDM, one main disadvantage of MIMO-OFDM is that the signals transmitted on different antennas might exhibit a prohibitively large peak-to-average power ratio (PAPR). Partial transmit sequence (PTS) provides attractive PAPR reduction performance in OFDM or MIMO-OFDM. Unfortunately, it leads to prohibitively large computational complexity. In this paper, types of low-complexity PTS schemes are proposed to reduce the PAPR for MIMO-OFDM systems that use Firefly algorithm (FA) and space-frequency block codes (SFBC). Simulation results show that FA based on PTS can reduce computational complexity dramatically and achieve better PAPR reduction performance compared to ordinary PTS by Ho-Lung Hung et al. [3].

The filter bank multicarrier with offset quadrature amplitude modulation (FBMC/OQAM) is being studied by many researchers as a key enabler for the fifth-generation air interface. In this paper, a hybrid peak-to-average power ratio (PAPR) reduction scheme is proposed for FBMC/OQAM signals by utilizing multi data block partial transmit sequence (PTS) and tone reservation (TR). In the hybrid PTS-TR scheme, the data blocks signal is divided into several segments and the number of data blocks in each segment is determined by the overlapping factor. In each segment, we select the optimal data block to transmit and jointly consider the adjacent overlapped data block to achieve minimum signal power. Then, the peak reduction tones are utilized to cancel the peaks of the segment FBMC/OOAM signals. Simulation results and analysis show that the proposed hybrid PTS-TR scheme could provide better PAPR reduction than conventional

PTS and TR schemes in FBMC/OQAM systems. Furthermore, we propose another multi data block hybrid PTS-TR scheme by exploiting the adjacent multi overlapped data blocks, called as the multi hybrid (M-hybrid) scheme. Simulation results show that the M-hybrid scheme can achieve about 0.2-dB PAPR performance better than the hybrid PTS-TR scheme et al. H. Wang [4].

Orthogonal Frequency Division Multiplexing (OFDM) has been widely used in various high data rate wireless communications standards. The high peak-to-average power ratio (PAPR) has however been known to be a constant problem in OFDM systems. The high PAPR in the OFDM system has led to many problems such as signal distortion, energy spilling to the adjacent channel and reducing system performance gradually. In this paper, a technique involving the manipulation of codeword using circulant shift will be introduced. The key idea of the proposed technique is to generate scramble data sequences like the conventional selective mapping (SLM) technique. The simulation results showed that the proposed technique overcame original OFDM signals and conventional SLM with a 19.5% improvement and 1.1 dB difference from conventional SLM. Besides that, the proposed technique offered a lower computationally complexity where the number of IFFT blocks can be reduced by about 57% as compared to conventional SLM et al. E. Abdullah [5].

efficiency is essential Energy in mobile communication networks. High Peak-Average Power Ratio (PAPR) has been an inherent drawback of Orthogonal Frequency Division Multiplexing (OFDM) for decades. The peak value of power signals causes two serious problems where it reduces the power efficiency of Radio Frequency (RF) amplifier and increases the computational complexity in analog to digital (A/D) and digital to analog (D/A) converters. Consequently, this would increase the cost of extending the linear range of the RF amplifier as well as the complexity of the A/D or D/A converter. The motivation to reduce the high PAPR is influenced by the current demands of **URT**M

International Journal of Innovative Research in Technology and Management (IJIRTM), Volume-3, Issue-2, 2019 ISSN: 2581-3404 (Online)

telecommunication consortium that are aiming for reduced power, high data rates and low-cost system. A method to reduce high PAPR by using this novel selective bit permutation method is introduced. This method does not only provide a better PAPR reduction performance but also to maintain the error performance at the receiver compared to the other method such as Selective Mapping (SLM) and Data Position Permutation (DPP) et al. Abdullah [6].

Multiple-Input multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) is reliable and most attractive technique for high data rate communications. MIMO uses spatial diversity to accept multiple "best" signals simultaneously. Each antenna is able to transmit or receive signals, where the legacy system can only accept the single "best" signal. The main drawback of orthogonal frequency division multiplexing systems is high Peak to Average Power Ratio (PAPR), which results in poor power efficiency, degradation in bit-error-rate (BER) performance, and spectral spreading efficiency. The needed measure for better wireless communication is to reduce PAPR. The proposed system introduces Adaptive Selected mapping (ASLM) techniques. In this technique, the sums of separated data blocks are created from an OFDM data block using a set of phase sequence. It chooses lowest PAPR and selects sequences for transmission. As an outcome, the adaptive selected mapping increases the power efficiency and reduces the impulse interference by P. Kothai et al. [7].

The high peak-to-average power ratio (PAPR) in orthogonal frequency division multiplexing (OFDM) systems not only increases the complexity of the analog-to-digital (A/D) and digital-to-analog (D/A) converters but also reduces the efficiency of the radio frequency (RF) power amplifier. In this paper, we present a data position permutation (DPP) method, which is based on a selected mapping (SLM) scheme, for reducing the PAPR in OFDM systems. The candidate signal on each branch of the SLM scheme is generated by permuting the position and rotating the phase of the original data. In addition, a modified DPP

method with lower bit error rate (BER) is proposed. The simulation results show that the proposed method provides better performance with regard to complexity, spectrum efficiency, and BER as compared to that of the SLM-based dummy sequence insertion (SLM-DSI) method et al. J. Wen [8].

The two related optimization problems, maximizing the minimum of weighted rates under a sum-power constraint and minimizing the sumpower under rate constraints, are considered. They assumed that the Gaussian input and that each signal is decoded at no more titan one receiver. The complexity is high because the steepest ascent algorithm for the weighted sum-rate maximization needs to be solved repeatedly for each weight vector searched by the ellipsoid algorithm. Then the solution does not satisfy the single-user waterfilling structure. They can be used in admission control and in guaranteeing the quality of service. In, finally the mappings were used for many other optimization problems by Amhaimar Lahcen et al. [9].

The real and imaginary parts of complex factor corresponding to in-phase components and quadrature components of OFDM symbols, respectively. It is to be noted that in ideal cases, the demodulation is performed based on the assumption of perfect symbol timing, carrier frequency, and phase synchronization. This is usually not practically possible to achieve; therefore, the demodulated signal will not be the exact replica of input signal; resulting in bit error rate (BER). The term BER can be mathematically expressed as the difference of the received demodulated data and the input data by Yuan Ouyang et al. [10]. URTM

International Journal of Innovative Research in Technology and Management (IJIRTM), Volume-3, Issue-2, 2019 ISSN: 2581-3404 (Online)

TitleAuthor/ Publicati onMethodolog yParamet et/ multiOQAM systemsW. Du/ IEEE based on 2016method EEF based on 2016Large ErrorPeak-to- Average Average Average Average of of of in and system with stimation nethonizatio n Scheme e of PTS- leschamed channel e of PTS- sheme for Chuan proving channelMethodolog performance PAPR stim system with system with system with system sity e of PTS- leschamed channelPAPR = stim permutationDesign permutation system system system system sity complex system <br< th=""><th>Table 1: Summ</th><th>ary of Liter</th><th>ature Review</th><th></th><th>FBMC /</th><th>Xu, and</th><th>PTS and TR</th><th>12 dB/</th></br<>	Table 1: Summ	ary of Liter	ature Review		FBMC /	Xu, and	PTS and TR	12 dB/
Publicati onyer/ Demerit Demerit Demerit Demerit Demerit Sachor MIMO- PowerJunhui Design System with calculat e BER of OFDM No calculat PFMC/OQ 2017 AM Signal Using a Joint OPEM Scheme Preduction n BER and PAPR Scheme of press No Distribution Scheme e of PTS Hug, Phyrid Hybrid Performanc e of PTS Hang, Scheme for ChannePAPR PAPR = State PAPR = Scheme PAPR Communica 2017 Clipping 2017 Clipping 2017 Clipping 2017 Clipping Scheme for PAPR Communica 2016PAPR = State PAPR = Scheme PAPR Complex Scheme for Clipping Scheme for Clipping Scheme for Clipping 2017 Clipping 2017 Clipping 2017 Clipping 2017 Clipping 2017 Clipping 2017 ClippingPAPR = State Scheme for Clipping Scheme for Clipping Scheme for Clipping 2017 Clipping 2017 Clipping 2017 ClippingPAPR = Scheme for Clipping Scheme for Clipping Scheme for Clipping 2017 Clipping 2017 Clipping 2017 ClippingPAPR = Scheme for Scheme for Clipping Scheme for Clipping 2017 Clipping 2017 Clipping 2017 Clipping 2017 ClippingPAPR = Scheme for Scheme for Clipping Scheme for Clipping 2017 Clipping 2017 Clipping 2017 Clipping 2017 ClippingPAPR = Scheme for Scheme for Clipping 2017 Clipping 2017 Clipping 2017 Clipping Scheme for MIMO- Clipping Scheme for MIMO- Clipping Scheme for MIMO- Clipping Scheme for MIMO- Clipping Scheme for MIMO- Clipping Scheme for <br< td=""><td>Title</td><td>Author/</td><td>Methodolog</td><td>Paramet</td><td>OQAM</td><td>W. Du/</td><td>method</td><td>Large</td></br<>	Title	Author/	Methodolog	Paramet	OQAM	W. Du/	method	Large
onPerformance reduction in MIMO- StanajioDesign system with system with system with calculat eBER ino-Dinear clipping techniquePAPR stad system with calculat eBER ino CirculantDesign multi data block PTS and TR methodsPAPR and TR methodsMiMO- of in Scheme point Dominizatio n in Scheme techniquesDesign prise system with system with prise system with prise system with prise comple primizationDesign prime system with prime system with prime system with prime comple prime comple prime comple prime comple prime comple prime system with prime comple prime comple prime comple prime comple prime comple prime comple prime comple prime comple prime comple prime comple prime comple prime comple prime comple prime system with prime comple		Publicati	v	er/	systems	IEEE		Error
endsmultidataPeak-to- AverageZhao, PhangDesignPAPR = 8 dB, 2000PAPR = 8 dB, 2000and TR methodsDesignPAPR = gandPower Ratio NiNiand system with calculat clippingPTS with e BER clippingPTS with e BER clippingE.Design gand on circular system with systemPAPR = goodFBMC/OQ OD Dofimi Using and pAPR signal Using on in BER system with system with system with provisati chemiquePAPR = provisati system with provisati comple system with provisati chemiquePAPR = provisati system with provisati comple system with provisati channel estimation reduction in MIMO- friefly friefly Hagorithm Chang- friefly Hagorithm Chang- friefly Hagorithm Chang- friefly Hagorithm Chang- friefly Hagorithm Chang- friefly Hang, system with SFBC Ching- MIMO- Chang- HybridDesign PAPR = MIMO- friefly hand system with SFBC ching- MIMO- friefly HybridDesign HAR SFBC ching- MIMO- friefly Hybrid H Hybrid HybridDesign H, b-Lung system with SFBC ching- MIMO- friefly HybridDesign HAR System with SFBC ching- MIMO- Chang-PAPR = HAR = APAR System with System with System with System and system with System and comple system with System and system with System and system with System and system and portionPAPR PAPR PAPR Shill Adaptive Shill Adaptive Shill <td></td> <td>on</td> <td></td> <td>Demerit</td> <td>based on</td> <td>2016</td> <td></td> <td></td>		on		Demerit	based on	2016		
Peak-to- Average PowerJunhui Zhao, 				S	multi data			
Average PowerZhao, ShanjinMINO- OFDM=8 dB, No system with calculat e BER non-linear clipping techniqueand and calculat e BERand methods minimizing High PAPR System based System lidris, A. system based bit correlating some method signal using and PAPR Sai of minear optimizatio non BER some method some method<	Peak-to-	Junhui	Design	PAPR	block PTS			
Power Ratio Ratio Ni and Reduction of IEEE FBMC/OQ 2017OFDM system with clipping techniqueNo calculat e BER non-linear clipping techniqueNo calculat e BER non-linear clipping techniqueMo calculat e BER non-linear clipping techniqueNo calculat e BER non-linear clipping techniqueMo calculat e BER no-linear clipping techniqueNo calculat e BER no-linear clipping techniqueMo e BER no-linear clipping techniquePAPR = and systemDesign provide methodPAPR = system bit not permutation not system basedPAPR = good signal system basedPAPR = good signal system basedPAPR = good signal system basedPAPR = good signal system bit not permutation permutation permutation prover 2016 (PAPR) reduction in oFDMDesign prover permutation permutation permutation signal amplifie and power 2017 channelDesign pAPR = permutation permutation signal amplifie and permutationPAPR permutation permutation permutation permutationPAPR permuta	Average	Zhao,	MIMO-	=8  dB, /	and TR			
Ratio ReductionNiand Yi Gong/ PTSsystem with vith ecalculat eMinimizing eE. High PAPR AbdullahDesign OFDM A A A System based bitPAPR = 9dBR	Power	Shanjin	OFDM	No	methods			
ReductionYi Gong/ IEEEPTS with non-linear clipping techniquePTS with of non-linear clipping techniqueHigh PAPR system basedAbdullah n on system based tar.OFDM g g dB, son on circular I1 dB/ spstem sift componentiation9 dB, BER = son on circular I1 dB/ spstem based spstem based spstem based spstem based spstem based spstem based spstem based spstem based spstem based bit spstem based porticular I1 dB/ spstem based bit permutation power 2016OFDM spstem based positical spstem based bit permutation power 2016OFDM spstem based power 2016OFDM spstem based bit permutation permutation good signal spstem based permutation	Ratio	Ni and	system with	calculat	Minimizing	E.	Design	PAPR =
ofIEEE FBMC/OQon-linear clippingon-linear clippingon-linear clippingon-linear clippingon circularl dB/ aAM Signal Using2017techniquestableSystemldris, A. Systemsystem basedBER = SystemJoint Optimizatio n in BER softemAshna OFDMDesignPAPR = NIMO-Sinit CodeCodeSystem basedBER =Improvisati Ashna on in BER softemAshna OFDMDesignPAPR = NIMO-SelectiveE. Bit permutationDesignPAPR = Abullahbit techniqueGarsha, reduction in MIMO-Garsha, techniquePTS techniqueSignal amplifie dSaparon/ AverageAbullah DitimonNot system basedBER =Porformanc techniqueHo-Lung permutationDesign system with systemPAPR = mitMO-Not systemSignal amplifie dPerformanc techniqueHo-Lung permutationDesign system with system with system with system with systemPAPR = systemDesign systemPAPR = Reduction in MIMO-Design system with systemPAPR = soldAlgorithm ton Speem for MIMO- Chen/ OFDMDesign systemPAPR = soldNotSLM-Based soldJ. Wen, system with soldDesign systemPAPR = soldPAPR Reduction tionSPBC ChingDesign OFDMPAPR = soldSLM-Based soldJ. Wen, soldDesign sold </td <td>Reduction</td> <td>Yi Gong/</td> <td>PTS with</td> <td>e BER</td> <td>High PAPR</td> <td>Abdullah</td> <td>OFDM</td> <td>9 dB,</td>	Reduction	Yi Gong/	PTS with	e BER	High PAPR	Abdullah	OFDM	9 dB,
FBMC/OQ AM Signal Using a Joint Optimizatio2017clipping techniqueSignal techniqueSignal techniqueSaparon/ signal signal wordon circular signal signal word11 dB/ signal signal wordOptimizatio n SchemeAshna on in BER kakkar, and PAPR Sai OFDMDesign OFDMPAPR = bit techniqueSoparan/ signal wordSaparon/ signal system sith system with comple permutation in MIMO- Grasha, reduction in MIMO- Grasha, reduction jasin and channel estimation frierfly Algorithm Ching- Scheme for Chuan Algorithm Ching- Scheme for Chuan and Algorithm Ching- Scheme for Chuan and MIMO- Chen/ OFDMPAPR = person mithou system with system for techniquePAPR = permutation systemNot system systemNot system systemPAPR R ndMIMO- Ching- Scheme for MIMO- Chem/ OFDM in SystemsPAPR = permutation systemPAPR = systemDesign system systemPAPR = systemMIMO- Ching- SystemsChing- ching- systemPAPR = and systemDesign systemPAPR = systemPAPR R PAPR reduction tionH BEE systemDesign systemPAPR = systemDesign systemPAPR = systemPAPR reduction tionH BEE <b< td=""><td>of</td><td>IEEE</td><td>non-linear</td><td></td><td>in OFDM</td><td>, A.</td><td>system based</td><td>BER =</td></b<>	of	IEEE	non-linear		in OFDM	, A.	system based	BER =
AMSignal Using optimizatio n SchemetechniqueusingSaparon/ Circulantshiftcode goodOptimizatio n SchemeAshna OrinDesignPAPR =Improvisati AshmaAshna Orin BER Nybrid Communica techniquesDesign OFDMPAPR =Improvisati by using Nitesh hybrid ChanelDesign OFDMPAPR =MIMO- by using nd MIMO- Channel estimation techniquesDesign techniquePAPR =MIMO- Channel estimation techniquesDesign techniquePAPR =Performanc firefly Algorithm Ching- Scheme for Chuna tim SFBC Communica tom SystemsDesign techniquePAPR =MIMO- Ching- SystemsDesign techniquePAPR =Design techniquePAPR =MIMO- Ching- SystemsDesign techniquePAPR =Design techniquePAPR =MIMO- Ching- SystemsSFBC techniqueDesign techniquePAPR =Design techniquePAPR =MIMO- Ching- SystemsDesign techniquePAPR =Data StLMStLM techniqueNotSystemsDesign techniquePAPR =Data techniqueStLM techniqueStLM techniquePAPR =MIMO- Ching- SystemsDesign techniquePAPR =MIMO-9.2 dB,OFDM tornEEE techniqueStLM techniqueStLM techniqueStLM techniqueStLM techniqueStLM techniqueStLM techn	FBMC/OQ	2017	clipping		System	Idris, A.	on circular	11 dB/
Using Joint Optimizatio n SchemeDesign MIMO-PAPR = S.5, dB, MIMO-Circulant Shift CodeIEEE 2016word method signal strengthImprovisati Appration by using Nitesh hybrid Garsha, reduction Garsha, PDFDM (Jasvi techniques leachniquesDesign MIMO- V/More system with system with comple xity techniquePAPR = S.5, dB, Nore techniqueE.Design Addultah permutation method for peak- Saparon/ bit not selective power 2016PAPR = Design method for Peak- Saparon/ bit not signal amplifie dOFDM in MIMO- OFDM channelDesign PAPR = MIMO- Scheme for Chuan pAPR in SFBC Ching MIMO- Chen/ OFDM systemsDesign PAPR = Addition SFBC Ching MIMO- Chen/ OFDM SystemsPAPR = R R Adaptive in MIMO- System Scheme for Chuan 2016Design PAPR = Addition SFBC Ching MIMO- Chen/ OFDM SystemPAPR = Stade STBC Ching SFBC Ching MIMO- Chen/ OFDM SystemDesign PAPR = Adaptive StadePAPR = Stade StadeDesign PAPR = StadeMIMO- Chen/ SystemsDesign PAPR = APAPR Not SystemsPAPR = StadeJ. Wen, Design PAPR = StadeDesign PAPR = StadeMIMO- Ching SystemsDesign PAPR = APAPR Not SystemsPAPR = StadeJ. Wen, Design PAPR = StadeDesign PAPR = StadeMIMO- Ching SystemsDesign PAPR = APAPR SystemPAPR = StadeDesign	AM Signal		technique		Using	Saparon/	shift code	Not
Joint Optimizatio n SchemeShift Code2016signal strengthImprovisati on in BER and PAPR Sai by using hybrid in MIMO- Garsha, reduction techniquesDesign OFDM ytrik (Jasvi techniquePAPR = Solution techniqueShift Code2016signal strengthMIMO- by using hybrid in MIMO- Kritika/ OFDMDesign OFDMPAPR = techniqueEEE techniqueDesign techniquePAPR = techniqueestimation techniquesEEE of PTS- Hung, Based Y TS- techniqueDesign Design MIMO- SFBC to magePAPR = Not SFBC to magePAPR = techniquePerformanc Firefly Huag, Algorithm Ching- Scheme for Chuan in SFBC to mageDesign Design SFBC to magePAPR = techniqueDesign PAPR = Not SFBC to magePAPR = SLM StableJ. Wen, Design PAPR = Data SLM StableJ. Wen, Design SchemeDesign PAPR = SLM StablePAPR = SLM SLMMIMO- OFDM tion systemsDesign PAPR = APAPR to magePAPR = SLM StableJ. Wen, Design StablePAPR = Data SLM SystemsJ. Wen, Design System with StableJ. Wen, StablePAPR = SLM Ching- SystemsMIMO- Ching- SystemsDesign PAPR and Reduction to noPAPR = SLM StableJ. Wen, StableDesign SLM StablePAPR = SLM StableMIMO- Ching- SystemsDesign PAPR and Reduction to noDesign PAPR <br< td=""><td>Using a</td><td></td><td>_</td><td></td><td>Circulant</td><td>IEEE</td><td>word method</td><td>good</td></br<>	Using a		_		Circulant	IEEE	word method	good
Optimizatio n SchemeSelectivewordstrengthImprovisati and PAPRAshna on in BER Kakkar, and PAPR Sai by using Nitesh hybrid in MIMO- Garsha, reduction ojasvi techniquesDesign PAPR = 8.5, dB, OFDM ystem with oFDM in MIMO- Mitesh in MIMO- Mitesh in MIMO- Reduction estimation techniquesDesign PAPR = Not system with system with systemPAPR = 8.5, dB, ofFDM ystem with it comple xitywordSelective bit Abdullah permutation , A. system based permutation goodDesign permutation goodPortornanc e of PTS- Hung, Based Yung-Fa Ching- Scheme for OFDM in SFBC Communica 2016Design persing system with system with systemJene system system systemDesign system systemPAPR = system systemPAPR reduction in SystemChing- system systemPAPR = systemJene system systemDesign systemPAPR = systemPAPR roduction systemsChing- systemDesign systemPAPR = systemJ. Wen, system <t< td=""><td>Joint</td><td></td><td></td><td></td><td>Shift Code</td><td>2016</td><td></td><td>signal</td></t<>	Joint				Shift Code	2016		signal
n Scheme	Optimizatio				word			strength
Improvisati on in BER (Aakkar, and PAPR SaiDesign (MIMO- 8.5, dB, S, dB, and PAPR and PAPR (Saparon/ bit (Garsha, Immunodiated changes)PAPR = 8.5, dB, (MIMO- (Saparon/ bit (Carsha, and techniques)bit (Carsha, (Carsha, PTS)bit (Comple (Carsha, PTS)bit (Carsha, (Carsha, PTS)bit (Carsha, (Carsha, PTS)bit (Carsha, (C	n Scheme				Selective	E.	Design	PAPR =
on in BER and PAPR SaiKakkar, OFDMMIMO- / More comple xity8.5, dB, / More comple xitypermutation method for lars, A. Datasystem based bit permutation method for lars, A. do not selective permutation goodby using hybrid reduction in MIMO- Channel estimation techniquesJain and itechnique, A. MIMO- witesh system with xitysystem with oth xitypermutation permutation method for lars, A. do not permutation goodOFDM employing channel estimation techniquesJain and itechniquenot method for lars, A. dot permutation goodnot system goodPerformanc e of PTS- Hung, Rased Yung-FaDesign MIMO- System with suitable system with suitable large TxPAPR P. Reduction kothai large TxP. P. Design MIMO- SLMDesign PAPR = NotPAPR eduction for scheme for Chung StremsDesign PAPR = Reduction chingPAPR = SLM SLMDesign SLMPAPR = SLMMIMO- Ching toon toon SystemsChing ChingPAPR = Reduction Reduction toonDesign PAPR = SLMPAPR = SLMHybrid H. PAPR reduction toonDesign PAPR = System andPAPR = Reduction in OFDMAmhaim DesignPAPR = SLMHybrid H. PAPR reduction scheme forH. L besignPAPR = SystemAmhaim DesignDesign PAPRHybrid H. PAPR reduction toonH. 	Improvisati	Ashna	Design	PAPR =	bit	Abdullah	OFDM	9 dB,
andPAPRSaiOFDM/ More comple xitymethod forIdris, A.on selective10 dB/by usingNitesh system withsystem with system withcomple xitysignalnotreductionQjasvi techniquestechniquexityPeak- AverageSaparon/ permutationbit permutationnotreductionMIMO- Kritika/Kritika/Prover and2016methodsignal amplifieOFDMIEEE estimation2017Power2016methodsignal amplifietechniquesPort e of PTS- BasedHo-Lung MIMO-Design NotPAPR = ReductionNotSystemPAPR = NotBasedYung-Fa OFDMOFDMNotSILMSLMNotSILMNotAlgorithmChing- SFBCSFBC for large TxJ. Wen, PermutationDesign AdaptivePAPR = DataSLMSLMNotMIMO- Chen/Chen/DesignPAPR = APARMIMO-SchemeMIMO- PermutationJ. Wen, IEEEDesign PAPR = System withBER = CompleOFDMBER = SchemeOFDMBER = SchemeOFDMBER = SchemeMIMO-SLMNotStallMIMO-Chen/ Communica2016SLMSLMSLMSdB/ SystemSLMLarge compleStallSLMSdB/ SystemSlALLarge compleSystemSlALLarge compleSystemSlAL<	on in BER	Kakkar,	MIMO-	8.5, dB,	permutation	, A.	system based	BER =
byusing hybridNitesh Garsha, PTSsystem with PTScomple xityPark- xitySaparon/ IEEE permutationbit permutation goodnot goodreduction in MIMO- Kritika/ OFDMJain and in EEE estimationreduction in OFDMDesign PAPR = local PerformancPapr PAPR = local PAPR = MIMO- ChannelPapr PAPR = PAPRDesign PAPR = PAPR = PAPRPAPR = PAPR = PAPR = PAPR = PAPRDesign PAPR = PAPR = PAPR = PAPR = PAPRPAPR = PAPR = PAPR = PAPR = PAPR = PAPR = PAPR Wang, OFDMPAPR = PAPR = PAPR = PAPR = PAPR = PAPR wang, OFDMDesign PAPR = PAPR = PAPR = PAPR = PAPR wang, OFDMDesign PAPR = PAPR = PAPR = PAPR wang, OFDMPAPR = PAPR = PAPR = PAPR = PAPR wang, OFDMPAPR = PAPR = PAPR = PAPR wang, OFDMPAPR = PAPR = PAPR = PAPR wang, OFDM wang, L, based on BER = PAPR = PAPR wang, PAPR wang, PAPR wang, PAPR = PAPR wang, PAPR wa	and PAPR	Sai	OFDM	/ More	method for	Idris, A.	on selective	10 dB/
hybrid reduction dian and in MIMO- Kritika/PTS techniquexity techniqueAverage Power 2016IEEE 2016permutation methodgood signal amplifie dOFDM estimation techniquesIEEE estimation techniquesDesign MIMO- SoftemPAPR = NotPAPR = PAPR = NotPAPR = PAPR = Not UsingDesign MIMO- Not system with Sitable for large TxPAPR PAPR = Not SchemePAPR = Not SchemeDesign PAPR = Not SchemePAPR = Not SchemePAPR = Not SchemePAPR = Not SchemePAPR = Not SchemeHybrid tion systemsLe DesignDesign PAPR = NotPAPR = Not SchemeJ. Wen, SchemeDesign PAPR = SLMPAPR = NotHybrid techniqueDesign SystemsPAPR = NotSLM-Based SLM-BasedJ. Wen, IEEE SchemeDesign PAPR = NethouPAPR = NotHybrid techniqueDesign NotPAPR = NethouPAPR = NethouSLM-Based SLM-BasedJ. Wen, IEEE SchemeDesign NotPAPR = NethouHybrid teduction tion SchemeDesign NotPAPR = NethouPAPR = NethouSLM NotSLM SubmeLarge Comple NethouSystemNethou NotHybrid teduction tion SchemeMimo- NotDesign NotPAPR = NethouPAPRNethou NotSLM NotSLM NotHybrid reduction too SchemeMimo- NotDesi	by using	Nitesh	system with	comple	Peak-	Saparon/	bit	not
reduction techniquesOjasvi tain and in MIMO- Kritika/ OFDMtechniquereduction in (PAPR)Power Ratio (PAPR)2016methodsignal amplifie dOFDM techniquesIEEE estimation techniquesDesign MIMO- SoftmanPAPR = MIMO- Softman Softman PAPRPAPR = Reduction in MIMO- Softman Softman PAPR and Reduction in SFBC Communica 2016Design Design Softman Softman PAPRPAPR = Reduction in MIMO- Softman Softman Softman Softman MIMO-PAPR = Reduction in MIMO- Softman Softman Softman Softman MIMO- Softman Communica 2016Design Design Softman Softman PAPRPAPR = Reduction in MIMO- Softman Softman Softman Softman Softman Softman MIMO- Softman MIMO- Softman MIMO- Softman MIMO- Softman Communica 2016Design Softman PAPR = Softman PAPR = Softman Softman PAPR Reduction Reduction Softman Softman PAPR Reduction Softman PAPR Reduction Softman PAPR Reduction Softman PAPR Reduction Softman PAPR Reduction Softman PAPR Reduction Softman PAPR Reduction Softman PAPR Reduction Softman PAPR Reduction Softman PAPR Reduction Softman PAPR Reduction Softman PAPR Reduction Softman PAPR Reduction Softman PAPR Reduction Softman PAPR PAPR Reduction Softman PAPR PAPR Reduction Softman PAPR Reduction Softman PAPR Reduction Softman PAPR PAPR PAPR PAPR PAPR PAPR PAPR PAPR PAPR PAPR PAPR PAPR PAPR	hybrid	Garsha,	PTS	xity	Average	IEEE	permutation	good
techniquesJain and inMIMO- Kritika/ IEEEAmplifieamplifieOFDMIEEEamplifieemploying2017d </td <td>reduction</td> <td>Ojasvi</td> <td>technique</td> <td></td> <td>Power</td> <td>2016</td> <td>method</td> <td>signal</td>	reduction	Ojasvi	technique		Power	2016	method	signal
inMIMO- VOFDMKritika/ IEEEdOFDMIEEEdestimation2017<	techniques	Jain and			Ratio			amplifie
OFDM employing channelIEEE 2017reduction in OFDMreduction in OFDMestimation techniquesDesign PAPR e of PTS- Hung, Based Algorithm Ching- Scheme for Chuan in SFBC in SFBC in SFBC ChingPAPR = 8.7 dB/ Not large TxPAPR R Reduction large TxP. Reduction Kothai Im MIMO- OFDMDesign MIMO- 9.2 dB, Not Using AdaptivePAPR = Reduction MIMO- SLMPAPR = NIMO- OFDMPAPR Reduction in SFBC Communica tion SystemsPAPR = Reduction techniquePAPR = SLMDesign Not SchemePAPR = NotMIMO- OFDM tion SystemsChing DesignPAPR = Reduction Im SFBC Communica 2016PAPR = Reduction Reduction SystemsDesign PAPR = SLMPAPR = SLMHybrid H. PAPR Reduction X. System Scheme forDesign PAPR = RATHPAPR = PAPR = PAPRDesign PAPR = PAPR Reduction AddPAPR = PAPR Reduction AddDesign PAPR = PAPRHybrid H. Reduction X. System Scheme forPAPR = PAPR = NampPAPR = PAPR PAPRPAPR = PAPR PAPRPAPR PAPR PAPRHybrid H. Reduction X. System Scheme forPAPR = PAPR = NampPAPR = PAPRPAPR PAPRHybrid Reduction Scheme forH. Design PAPR NotPAPR = PAPRPAPR PAPRPAPR PAPRPAPR Reduction Scheme forMang, Design Dased OFDMPAPR = PAPRPAPR PAP	in MIMO-	Kritika/			(PAPR)			d
employing channel estimation2017OFDMOFDMrechniquesNotSystemPAPR =e of PTS- Hung, BasedMIMO-8.7 dB/BasedYung-FaOFDMNotFireflyHuang, system with Scheme for Chuan in SFBCSFBC techniquePAPR =AlgorithmChing- techniqueSFBC for large TxSLMOFDMScheme for OFDMRung- in SFBCImage TxSLM-Based SchemeJ. Wen, IEEE SchemeDesign MIMO-PAPR =MIMO- OFDMChen/ OFDMDesign techniquePAPR =MIMO-9.2 dB, MIMOMIMO- OFDMRung- in SFBCfor techniqueSLM2015SLMNotStemeSLM-BasedJ. Wen, PositionDesign C. KungPAPR =MIMO- OFDMChen/PAPR =MIMO-9.2 dB, SLMOFDMIEEE toonSLMSLMSLMSLMOFDMIEEE toonStableSLM-BasedJ. Wen, PositionDesign C. KungPAPR =PAPR toonWang, OFDM8.7 dBPAPR reductionSystemsMIMO-=9.5PAPR reductionX. X. SystemSystemand and andSystemPAPRPAPR reductionK. X. X. SystemPAPR =PAPR reductionPAPR and an andPAPRPAPR reductionK. X. X. SystemSystemand an and and and an and <td< td=""><td>OFDM</td><td>IEEE</td><td></td><td></td><td>reduction in</td><td></td><td></td><td></td></td<>	OFDM	IEEE			reduction in			
channel estimation techniquesSystemsystemsystemPAPR =Parformanc e of PTS- Based Firefly Algorithm Scheme for DAPR in SFBC OFDMDesign Design MIMO- SFBC Ching MIMO- techniquePAPR =PAPR Reduction for large TxPAPR Reduction MIMO- SchemeP.Design MIMO- SLMPAPR =PAPR Reduction Reduction in SFBC Communica tion SystemsOFDM techniqueNotNotNotSERC DAPR in SFBC Communica tion SystemsSFBC Ching MIMO- DFDMfor techniqueIarge TxNotSLM-Based tion SystemsJ. Wen, DesignDesign PAPR = Data PAPR PAPR PAPR Reduction X.PAPR = StameNotHybrid H. PAPR reduction X.Design PAPR And NotPAPR = NotNotPAPR Wang, reduction SystemsDesign PAPR = NotPAPR = NotPAPR PAPR PAPR PAPRDesign Not Hybrid H. DesignPAPR = NotPAPR reduction SystemsDesign Not HybridPAPR = NotPAPR PAPR PAPR reduction Scheme forDesign Not NotPAPR = NotPAPR PAPR PAPR PAPRDesign Not NotPAPR = NotPAPR reduction Scheme forDesign NotPAPR = NotPAPR reduction Scheme forOFDM Not8.7 dB NotPAPR reduction Scheme forDesign NotPAPR NotPAPR reduction <b< td=""><td>employing</td><td>2017</td><td></td><td></td><td>OFDM</td><td></td><td></td><td></td></b<>	employing	2017			OFDM			
estimation techniquesPAPRP.DesignPAPR =rechniquesNotPAPR =ReductionKothaiMIMO-9.2 dB,PerformancHo-LungDesignPAPR =ReductionKothaiMIMO-9.2 dB,asedYung-FaOFDMNotNotStandardBER =OFDMNotFireflyHuang, System withsystem withsuitable forforSLMSLMNotAlgorithmChing- SFBCSFBCforSchemeSLM2015Scheme-PAPRandandReductionRung-Image TxSLM-BasedJ. Wen, DesignDesignPAPR =MIMO-ChingImage TxSLM-BasedJ. Wen, DesignDesignPAPR =MIMO-Chen/Image TxSLM-BasedJ. Wen, DesignDesignPAPR =MIMO-Chen/Image TxSLM-BasedJ. Wen, DesignDesignPAPR =PAPRImage TxImage TxSLM-BasedJ. Wen, DesignDesignPAPR =PositionC. KungOFDMBER =Image TxSLMLargeOFDMIEEEImage TxMethod for PAPR2015SLMLargeCommunica2016Image TxSystemsImage TxSystemImage TxHybridH.DesignPAPRReduction Image TxSystemImage TxHybridH.DesignPAPRImage TxSystemsIma	channel				system	_		
ItechniquesImage: ConstructionReductionKothaiMIMO-9.2 dB,PerformancHo-LungDesignPAPR =e of PTS-Hung,MIMO-8.7 dB/BasedYung-FaOFDMNotFireflyHuang,system withsuitableAlgorithmChing-SFBCforScheme forChuantechniquelarge TxPAPRandSFBCforReductionRung-inSLMinSFBCChingStableMIMO-Chen/DesignPAPR =OFDMIEEEDataS. Lee,MIMO-Chen/DesignPAPR =OFDMIEEEPositionC. KungOFDMIEEEPermutation/ IEEEVordetion2016PAPR =PAPRWang,OFDM8.7 dBPAPRWang,OFDM8.7 dBPAPRWang,OFDM8.7 dBreductionX.Systemandscheme forWang, L.based onBER =PAPRAmhaimDesignPAPRreductionX.SystemandScheme forWang, L.based onBER =PAPRMandDesignPAPRPAPRGFDM8.7 dBPAPRreductionX.SystemImageeScheme forWang, L.based onBER =PAPRGFDM8.7 dBImageePAPRGFDMBER	estimation				PAPR	P.	Design	PAPR =
PerformancHo-LungDesignPAPR =eof PTS-Hung,MIMO-8.7 dB/BasedYung-FaOFDMNotFireflyHuang,system withsuitableAlgorithmChing-SFBCforScheme forChuantechniquelarge TxPAPRandReductionRung-inSFBCforSLMinSFBCforScheme forChinglarge TxPAPRandSLM-BasedJ. Wen,DesignPAPR =MIMO-Chen/IEEECommunica2016IEEEtionsystemandHybridH.DesignPAPR =PAPRWang,OFDM8.7 dBPAPRWang,OFDM8.7 dBreductionX.Systemandscheme forWang, L.based onBER =PAPRGFDM8.7 dBgetformancLabcenGFDMBER =PAPRMiMO9.5	techniques			D / DD	Reduction	Kothai	MIMO-	9.2 dB,
e of PTS-Hung,MIMO-8.7 dB/OFDMPrabhusystem with5.3 dB/BasedYung-FaOFDMNotUsingM.E/SLMNotFireflyHuang,system withsuitableforSLM2015stableAlgorithmChing-SFBCforIarge TxSchemeSchemeSchemestablePAPRandtechniquelarge TxSLM-BasedJ. Wen,DesignPAPR =ReductionRung-nSLM-BasedJ. Wen,DesignPAPR =MIMO-Chen/DesignPAPRStLMSLMBER =OFDMIEEEPositionC. KungOFDMBER =Communica2016PAPRtechniquecompletionSystemsPAPRReductionxityxityHybridH.DesignPAPR =PAPRWang,OFDM8.7 dBPAPRAmhaimDesignreductionX.SystemandsystemsPAPRAmhaimDesignreductionX.SystemandsystemsPAPRAmhaimDesignPAPRscheme forWang, L.based onBER =PerformancLabcenOFDMdB/	Performanc	Ho-Lung	Design	PAPR =	in MIMO	and R.	OFDM	BER =
BasedYung-FaOFDMNotFireflyHuang, Algorithmsystem with Ching-suitable forAdaptiveIEEEtechniquestableAlgorithmChing- SFBCSFBCforlarge TxSLM2015stablePAPRandtechniquelarge TxSLM-BasedJ. Wen, DataDesignPAPR = DataReductionRung- inSFBCChingDataS. Lee, PositionMIMO- GFDM9.2 dB, BER =MIMO-Chen/ OFDMIEEEAdaptiveIEEE St.MSystem with 8 dB/Communica2016AdaptiveIEEE PAPRSLMDesignPAPR = PAPRHybridH. PAPRDesignPAPR = PAPRsystemwith 8 dB/HybridH. PAPRDesignPAPR = PAPRsystemwith systemand systemsHybridH. PAPRDesignPAPR = PAPRPAPRmain arDesignPAPRPAPRWang, reductionGFDM8.7 dB reductionarMIMO- ar=9.5schemefor Vang, L. basedbasedonBER =performanceLabcenOFDM	e of PIS-	Hung,	MIMO-	8./ dB/	OFDM	Prabhu	system with	5.3 dB/
FireflyHuang, AlgorithmSystem with SFBCsuitable for large TxAdaptiveIEEEtechniquestableAlgorithmChing- Scheme for PAPRChuan and Reductiontechniquelarge TxSLM2015SchemePAPR =PAPR inSFBC SFBCChing MIMO-Rung- Chen/Image TxSLM-Based DataJ. Wen, SchemeDesign DesignPAPR =MIMO- OFDMChen/ IEEECommunica 20162016SLMBER =Communica tion Systems2016PAPR =Permutation Method for in OFDMSLMLarge comple xityHybrid reduction schemeH. System andDesign BAPR =PAPR =PAPR PAPR =Vang, in OFDMPAPR =PAPR reduction schemeWang, forOFDM BAPR =BAPR =PAPR AmhaimDesign PAPRPAPR Feduction arPAPR MIMO-PAPR FeductionHybrid reduction schemeH. based forDesign and BAPR =PAPR for andAmhaim ar AmhaimDesign PAPR Feduction arPAPR for MIMO-PAPR Feduction arHybrid reduction schemeK. for for for mangeSystem for<	Based	Yung-Fa	OFDM	Not	Using	M.E/	SLM	Not
AlgorithmChing- techniqueSFBCIor large TxScheme for PAPRand Reductionlarge TxSchemeSchemePAPR = DataReduction in SFBC OFDMRung- IEEESLM-Based PositionJ. Wen, DesignDesign PAPR = PositionPAPR = PositionMIMO- OFDMChen/ IEEEPosition PositionC. Kung PositionOFDM PositionBER = PermutationMIMO- OFDMIEEE ton SystemsPAPR = PAPRNethod for PAPR Reduction2015 SLMLarge techniqueHybrid reduction schemeH. PAPRDesign PAPR R systemPAPR = Reduction and ReductionPAPR Reduction arMIMO- PAPR PAPR PAPRPAPR reduction scheme for Wang, L, basedDesign PAPRPAPR = ABR AmhaimDesign PAPR PAPR	Firefly	Huang,	system with	suitable	Adaptive	IEEE	technique	stable
Scheme forChuantechniquelarge fxPAPRandSLM-BasedJ. Wen,DesignPAPR =ReductionRung-DataS. Lee,MIMO-9.2 dB,inSFBCChingPositionC. KungOFDMBER =MIMO-Chen/PositionC. KungOFDMBER =OFDMIEEEPermutation/ IEEEsystem with8 dB/Communica2016PAPRtechniquecompletionSystemsPAPRtechniquecompleHybridH.DesignPAPR =SystemstechniquePAPRWang,OFDM8.7 dBSystemsPAPRreductionX.Systemandreductionarscheme forWang, L.basedonBER =performancLahcenDataSetterSetterDataSetterSetterPAPRMang, L.basedonBER =performancLahcenDataSetter <td< td=""><td>Algorithm Sahama for</td><td>Ching-</td><td>SFBC</td><td>10F Jorgo Ty</td><td>SLM</td><td>2015</td><td></td><td></td></td<>	Algorithm Sahama for	Ching-	SFBC	10F Jorgo Ty	SLM	2015		
PAPKandPAPK =ReductionRung- inSEM-BasedJ. Wen, DesignPAPK =inSFBCChingDataS. Lee, MIMO-9.2 dB,MIMO-Chen/PositionC. KungOFDMBER =OFDMIEEEPermutation/ IEEEsystem with8 dB/Communica2016Method for2015SLMLargetionPAPRReductioninOFDM8.7 dBsystemsHybridH.DesignPAPR =SysteminOFDMPAPRWang,OFDM8.7 dBPAPRAmhaimDesignPAPRreductionX.SystemandreductionarMIMO-=9.5schemeforWang, L.basedonBERperformancLabcenOFDMdB/		ciluan	technique	large 1x	SUM Deced	I Wen	Dagian	
ReductionRung- inStataS. Lee, MIMO-MIMO-9.2 dB, BERinSFBCChing 	PARK	Bung			SLIVI-Dased	J. wen,	MIMO	PAPK =
InSFBCChingBERMIMO- OFDMChen/ IEEEPermutation/ IEEEsystem with Method for 2015SLMLargeCommunica2016PAPRReduction inOFDMLargecompletion systemsPAPRSystemtechniquecompleHybrid reduction scheme for wang, L basedOFDM8.7 dBPAPRAmhaimDesignPAPRPAPR reduction scheme for wang, L basedOFDM8.7 dBPAPRAmhaimDesignPAPRPAPR reduction scheme for wang, L basedMBRPAPRAmhaimDesignPAPRPAPR reduction scheme for wang, LBasedonBERPAPRAmhaimDesignPAPRPAPR reduction scheme forWang, L basedBASEPAPRAmhaimDesignPAPRPAPR reduction scheme forWang, L basedBASEPAPRAmhaimDesignPAPR	in SEPC	Ching			Data	S. Lee,	OEDM	9.2 UD, DED _
MinicipaCriteriaCriteriaSystem <th< td=""><td>MIMO_</td><td>Chen/</td><td></td><td></td><td>Position</td><td>C. Kung</td><td>or Divi</td><td><math>P = \frac{P}{2}</math></td></th<>	MIMO_	Chen/			Position	C. Kung	or Divi	$P = \frac{P}{2}$
Of DWHELLMichou for2015SEWLargeCommunica2016PAPRPAPRtechniquecompletionSystemsPAPRReductioninOFDMxityHybridH.DesignPAPR =SystemsPAPRsystemsvityPAPRWang,OFDM8.7 dBPAPRAmhaimDesignPAPRreductionX.SystemandreductionarMIMO-=9.5scheme forWang, L.based onBER =performancLahcenOFDMdB/	OFDM	IFFF			Method for	7 ILLE 2015	SI M	o uD/
tion SystemsDesign PAPRPAPR = Reduction inReduction inReduction of DMXityHybrid 	Communica	2016			PAPR	2013	technique	comple
NonNonNonNonNonSystemsH.DesignPAPR =inOFDMSystemsPAPRWang,OFDM8.7 dBPAPRAmhaimDesignPAPRreductionX.SystemandreductionarMIMO-=9.5schemeforWang, L.basedonBER =performancLahcenOFDMdB/	tion	2010			Reduction		teeninque	vity
HorizonH.DesignPAPR =PAPRWang,OFDM8.7 dBreductionX.Systemandscheme forWang, L.based onBER =	Systems				in OFDM			лцу
PAPR reductionWang, X.OFDM8.7 dB andPAPR reductionAmhaim arDesignPAPR PAPRscheme for wang, L.based basedonBER BERperformancLahcenOFDMdB/	Hybrid	Н	Design	PAPR =	Systems			
reduction X. System and reduction ar MIMO- scheme for Wang, L. based on BER = performanc Lahcen OFDM dB/	PAPR	Wang	OFDM	8.7  dB	PAPR	Amhaim	Design	PAPR
scheme for Wang, L. based on $BER = 1$ performanc Lahcen OFDM $dR/$	reduction	X.	System	and	reduction	ar	MIMO-	=95
	scheme for	Wang, L.	based on	BER =	performanc	Lahcen	OFDM	dB/

www.ijirtm.com

URTM

International Journal of Innovative Research in Technology and Management (IJIRTM), Volume-3, Issue-2, 2019 ISSN: 2581-3404 (Online)

e for	Ahvoud	system with	high
WiMAX	Saida,	pulse	comple
OFDM	Asselma	shaping	xity
systems	n Adel /	technique	•
	IEEE	-	
	2015		
Peak-to-	Yuan	Design	PAPR =
Average	Ouyang,	MIMO-	9.6 dB,
Power	Hungkai	OFDM	BER =
Ratio	Ding/	system based	7 dB/
Reduction	IEEE	on STBC/	Not
Techniques	2015	SBFC	suitable
for MIMO-		system	for high
OFDM		-	antenna
Systems			
with			
STBC/SFB			
С			

## **III SYSTEM MODEL**

MIMO in combination with OFDM is widely used nowadays due its best performance in terms of capacity of channels, high data rate and good outcome in frequency selective fading channels. In addition to this it also improves reliability of link. This is attained as the OFDM can transform frequency selective MIMO channel to frequency flat MIMO channels [8]. So it is widely used in broadband future wireless System or communications. Cyclic prefix is the copy of last part of OFDM symbol which is appended to the OFDM symbol that is to be transmitted. It is basically 0.25% of the OFDM symbol. We can say that one fourth of the OFDM symbol is taken as CP (cyclic prefix) and appended to each OFDM symbol. IFFT is used at the transmitter and FFT is used at the receiver which substitutes the modulators and demodulators. Doing so eliminates the use of banks of oscillators and coherent demodulators. Moreover the complex data cannot be transmitted as it is; therefore it is first converted to analog form which is accomplished by IFFT. It basically converts the signal from frequency domain to time domain. Prior to IFFT operation symbol mapping is performed which is nothing but the modulation block. Any of the widely used modulation techniques can be applied like BPSK, QPSK, QAM, PSK etc. Further there are higher

<u>www.ijirtm.com</u>

order modulations are also available which provide more capacity at little expense of BER performance degradation. After IFFT block pilot insertion is done and then CP (cyclic prefix) is added. Figure 1 below shows the block diagram constituting MIMO and OFDM. Any antenna configuration for the MIMO can be used according requirement. to the system Higher the configuration more will be the capacity and more will be the computational complexity of the transceiver design. It is seen that in the case of estimating channel the computational complexity is increased. Mapper defines the modulation to be used. Symbol encoder takes the shape of the STBC (Space Time Block Code) if spatial diversity is to be used and it takes the shape of the demultiplexer/multiplexer if spatial multiplexing is to be used.



Figure 1: MIMO-OFDM system model.

The received signal at j<sup>th</sup> antenna can be expressed as

$$R_{j}[n.k] = \sum H_{ij}[n,k] X_{i}[n,k] + W[n,k]$$
(1)

Where H is the channel matrix, X is the input signal and W is noise with zero mean and variance. Also  $b_i[n,k]$  represents the data block i<sup>th</sup> transmit antenna, n<sup>th</sup> time slot and k<sup>th</sup> sub channel index of OFDM. Here i and j denoted the transmitting antennas index and receiving antenna index respectively.

UIRTM

International Journal of Innovative Research in Technology and Management (IJIRTM), Volume-3, Issue-2, 2019 ISSN: 2581-3404 (Online)

The MIMO-OFDM system model [9] with NR receives antennas and NT transmits antennas can be given as:

$$\begin{bmatrix} Z_1 \\ Z_2 \\ \vdots \\ Z_N \end{bmatrix} = \begin{bmatrix} H_{1,1} & H_{1,2} & \dots & H_{1,NT} \\ H_{2,1} & H_{2,2} & \dots & H_{2,NT} \\ \vdots & \vdots & \ddots & \vdots \\ H_{NR,1} H_{NR,2} & \dots & H_{NR,NT} \end{bmatrix} \begin{bmatrix} A_1 \\ A_2 \\ \vdots \\ A_{NT} \end{bmatrix} + \begin{bmatrix} M_1 \\ M_2 \\ \vdots \\ M_{NT} \end{bmatrix}$$

Where, Z represents O/P data vector, H denotes Channel matrix, A denotes I/P data vector and M represents Noise vector. The wireless channel used is AWGN channel. After receiving the signal the CP is removed then the pilots are also removed from main signal received. After this the signal that is in time domain can be again converted to frequency domain by taking FFT of the received signal.

The sequence on each of the OFDM block is then provided to channel estimation block where the received pilots altered by channel are compared with the original sent pilots. Channel estimation block consists of the algorithms that are applied to estimate the channel.

**PTS Schemes** 

#### 1. SISO PTS Scheme

In the SISO-PTS scheme, the original data sequence in the frequency domain is partitioned into M disjoint, equal length sub blocks Xv (v = 1, 2... M) as follows.

$$X = \sum_{\nu=1}^{M} X$$

By multiplying some weighting coefficients to all the subcarriers in every sub-block, we can get the new frequency sequence.

$$X' = \sum_{\nu=1}^{M} b_{\nu} X_{\nu}$$

Finally, at each transmitting antenna, there are (V-1) sub blocks to be optimized, and the candidate sequence with the lowest PAPR is individually selected for transmitting. Assume that there are W allowed phase weighting factors. To achieve the optimal weighting factors for each transmitting

<u>www.ijirtm.com</u>

antenna, combinations should be checked in order to obtain the minimum PAPR [10].

### 2. Alternate PTS (A-PTS)

In, the idea of alternate optimization is introduced, and it can be also applied to PTS in multiple antennas OFDM systems, denoted as alternate PTS (A-PTS). Different from ordinary PTS, phase weighting factors are needed only for half of the sub blocks in A-PTS. That is to say, starting from the first sub block, every alternate sub block is kept unchanged and phase weighting factors are optimized only for the rest of the sub blocks, which leads to the reduction of computational complexity. In this way, the computational complexity is greatly reduced at the expense of PAPR performance degradation [11]. Employed spatial sub block circular permutation for A-PTS scheme to increase the number of candidate sequences which improves the PAPR performance further.



**Figure 2:** Block diagram of the PTS scheme with two transmit antennas.

UIRTM

International Journal of Innovative Research in Technology and Management (IJIRTM), Volume-3, Issue-2, 2019 ISSN: 2581-3404 (Online)

# IV EXPECTED OUTCOME

This research project expects to have the following outcomes by the end of the project.

• The PAPR of the MIMO-OFDM signal can also be reduced by using PTS with DWT and DCT technique.

• Analysis of the  $2\times1$ ,  $2\times2$  MIMO-OFDM system for 5G wireless communication.

• Analysis of the bit error rate (BER) for the different modulation technique and PTS with DWT and DCT technique.

• Analysis of the space time block code (STBC) used in MIMO-OFDM system and achieved better result.

## **V CONCLUSION**

An extended approach cooperative and alternate partial transmit sequence named PTS was proposed for STBC MIMO-OFDM - 5G which makes uses of conjoint optimization of the PAPR for both real and imaginary parts. A high PAPR, between the two antennas, is selected to be transmitted. The proposed method performs well in terms of simulation results as well as the complexity of computation.

## **REFRENCES:-**

[1] Junhui Zhao, Shanjin Ni and Yi Gong, "Peak-to-Average Power Ratio Reduction of FBMC/OQAM Signal Using a Joint Optimization Scheme", Received March 24, 2017, accepted April 26, 2017, date of publication May 19, 2017, date of current version August 29, 2017.

[2] Ashna Kakkar, Sai Nitesh Garsha, Ojasvi Jain and Kritika, "Improvisation in BER and PAPR by using hybrid reduction techniques in MIMO-OFDM employing channel estimation techniques", 7th International Advance Computing Conference, IEEE 2017.

[3] Ho-Lung Hung, Yung-Fa Huang, Ching-Chuan and Rung-Ching Chen, "Performance of PTS-Based Firefly Algorithm Scheme for PAPR Reduction in SFBC MIMO-OFDM Communication Systems", International Symposium on Computer, Consumer and Control, IEEE 2016. [4] H. Wang, X. Wang, L. Xu, and W. Du, "Hybrid PAPR reduction scheme for FBMC/OQAM systems based on multi data block PTS and TR methods", IEEE Access, vol. 4, pp. 4761\_4768, 2016.

[5] E. Abdullah, A. Idris, A. Saparon, "Minimizing High PAPR in OFDM System Using Circulant Shift Code word", J. Technology, vol. 78, no. 2, pp. 135-140, 2016.

[6] E. Abdullah, A. Idris, A. Saparon, "Selective bit permutation method for Peak-Average Power Ratio (PAPR) reduction in OFDM system", Adv. Sci. Lett., vol. 22, no. 10, pp. 2832-2836, 2016.

[7] P. Kothai and R. Prabhu M.E., "PAPR Reduction in MIMO OFDM Using Adaptive SLM Scheme", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Vol. 03, No. 05, pp. 729-735, May 2015.

[8] J. Wen, S. Lee, C. Kung, "SLM-Based Data Position Permutation Method for PAPR Reduction in OFDM Systems", Wireless Communication Mob. Computer, vol. 13, no. 11, pp. 985-997, 2015.

[9] Amhaimar Lahcen, Ahyoud Saida, Asselman Adel, "PAPR reduction performance for WiMAX OFDM systems", Third International Workshop on RFID and Adaptive Wireless Sensor Networks (RAWSN), pp. 29-32, 2015.

[10] Yuan Ouyang, Hungkai Ding, "Peak-to-Average Power Ratio Reduction Techniques for MIMO-OFDM Systems with STBC/SFBC", IEEE International Conference on Communication Problem-Solving (ICCP), pp. 540-543, 2015.

[11] Muhammet Nuri Seyman, Necmi Taspmar, "Channel estimation based on neural network in space time block coded MIMO-OFDM system", Digital Signal Processing, Vol. 23, No.1, pp. 275-280, Jan. 2013.