Comparative Analysis of Papr Using PTS and SLM Reduction Techniques for 5g Communication System

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***Abstract*: Enables license the quantity of subcarriers, high data rate and high unearthly proficiency. One of the significant downside in OFDM is the high top to average power ratio(PAPR). High PAPR prompts power shortcoming and sign contortion with pragmatic power intensifiers utilized at the transmitter. As in 5G framework use of ability to be productive and creator attempted to analyze the methods utilized for diminishing PAPR are cutting, particular planning (SLM),interleaving and fractional send sequence(PTS). In SLM , it delivers various option send groupings from similar information source and afterward chooses the communicate signal showing the least PAPR where as in PTS , there are two different ways of lessening PAPR , either by isolating the first OFDM signal into various sub-blocks or by duplicating the first OFDM signal with various stage arrangements.**

Keywords: 5G,ODFM, PAPR,SLM, PTS

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing is one of the types of different transporter tweak; it is appropriate for communicating information over a channel having dispersive way of behaving. Here the rule is that assorted transporters are symmetrical to one another. These various transporters are free of each other, and to accomplish this peculiarity the transporters are put precisely at the invalid space in the range of balance. In different subcarrier transmission advancements to accomplish high information rate transmission, no entomb image obstruction, and high range proficiency, the transporter signal is added through the IFFT cycle in the OFDM framework. OFDM is safe to particular fading.[1-4] OFDM is likewise utilized for sight and sound applications in view of its attributes. In this the information to be sent is spread over an enormous number of symmetrical transporters, each being regulated at a low rate. The carrier can be made symmetrical by fittingly picking the recurrence separating between them [21-25]. Thusly, OFDM is a high level regulation strategy that is appropriate for high velocity information transmission because of its benefits in managing the multipath engendering issue, high information rate, and data transfer capacity proficiency. OFDM has a few alluring elements which make it more profitable for high velocity information transmission over different information transmission methods.

Fifth Generation (5G) versatile correspondence standard is on the way to being mechanically practical in several years and is supposed to accomplish a huge change in various market spaces, for instance, rationale, business, industry, and public, to make reference to a couple Quite conceivably the most fundamental worry for completing 5G correspondence is picking the best waveform that is the best for that particular application. [5-8]

II. 5G EFFICIENCY

The new 5G framework needs to adjust and permit gadgets and organization parts to proactively pursue shrewd choices. For instance, the organization ought to choose whether to utilize information involving LTE or 5G innovation for explicit administrations or applications, utilizing measurements, for example, remaining battery level, RF strength, network burden, and asset accessibility, to give the best client experience and make a way for both organization and gadget power productivity [9-12]. Network administrators and gadget producers have consistently believed power execution and proficiency to be one of the basic 5G highlights for improvement and have kept on driving energy-productivity network thoughts into 3GPP principles[13-14]. The basic component of Energy efficient of 5G system shown in Figure 1.

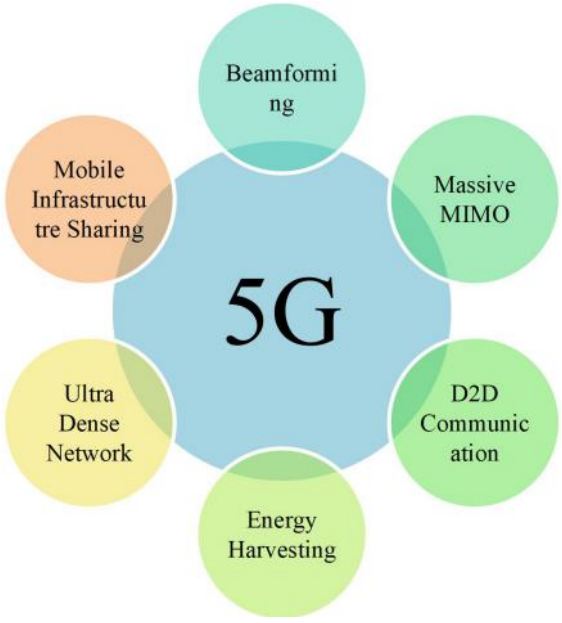

Fig. 1. Energy Efficiency of 5G System

The 5G NR standard has been planned in view of the information on the ordinary traffic action in radio organizations as well as the need to help rest states in radio organization hardware[19-22]. By placing the base station into a rest state when there is no traffic to serve for example turning off equipment parts, it will consume less energy[15-16]. The more parts that are turned off, the more energy we

will save. NR or 5G BTS, then again, expects far less transmissions of consistently on flagging transmissions. This, thus, takes into consideration both more profound and longer times of rest when there are practically no continuous information transmissions, which fundamentally affects the general organization energy utilization[17-18].

III. PAPR

To lessen PAPR in OFDM frameworks, two unique kinds of sign methods were utilized. The first is Signal scrambling strategies and the subsequent one is signal mutilation methods. Signal scrambling strategies contain various techniques including block coding, sub-block coding, Selective level planning (SLM), Interleaving strategy, Linear block coding, Tone infusion, Tone reservation and Partial send sequence(PTS) [18]. Signal bending strategies contain various techniques including signal cut-out and sifting, Envelope scaling, and Peak windowing methods. The PAPR of OFDM Signals x (t) is the proportion of pinnacle yield power and its typical power and it is addressed as

$$\text{PAPR}\,[\text{x(t)}] = \frac{\text{P}_{\text{Peak}}}{\text{P}_{\text{Average}}} = 10\log_{10}\frac{\max\,[|\text{X(n)}|^2]}{\text{E}[|\text{X(n)}|^2]} \quad (1)$$

Where P_{Peak} = greatest immediate result power $P_{Average}$ = Average pinnacle power E [.] = expected worth of the information signal. X(n) = communicated side OFDM Signals. These Transmitted side OFDM Signals are produced by playing out the IFFT procedure on regulated input information images XK and Xn is addressed as

$$x_n = \frac{1}{\sqrt{N}}\sum_{K=0}^{N-1} X_K W_N^{nk} \quad (2)$$

IV. TECHNIQUE USED

There are various techniques used for PAPR Reduction and two of the most used techniques are:

A. SLM(Selective Mapping):

Selective mapping (SLM) is a is a promising PAPR decrease procedure of the OFDM frameworks. Figure 2 shows the fundamental rule of Selective Mapping. The fundamental thought of SLM is to deliver U option send arrangements from similar information source and afterward select the communicate signal showing the most minimal PAPR.

Here X $= [X(0), \text{X}(1), \ldots\ldots X(N - 1)]$is multiplied with U different phase sequences

$$\text{P}^{\text{u}} = [p1^{u}, p2^{\text{u}}, \text{p3}^{\text{u}} \ldots\ldots p(N-1)^{u}] \quad (3)$$

where $\text{p}^{\text{u}}\text{v} = e^{j\emptyset}\epsilon(0, 2\pi)$, for

$V = 0, 1, 2, \ldots\ldots \text{N} - 1$, and $\text{U} = 1, 2, 3, 4, 5 \ldots\ldots \text{U}$

which produce a modified data block

$$\text{X}^{\text{U}} = \left[\text{X}^{\text{U}}[0], \text{X}^{\text{U}}[1], \text{X}^{\text{U}}[2], \text{X}^{\text{U}}[3] \ldots\ldots\ldots\ldots \text{X}^{\text{U}}[N-1]\right]^{T} \quad (4)$$

- Advantage:

A. No mutilation is presented.

B. Independent of number of transporters.

Drawback:

A.Side data is required.

B.Degrade BER execution

B. Partial Transmit Sequence (PTS)

is one of the strategies used to lessen PAPR in the OFDM framework which is executed [25]. The fundamental thought of PTS is information blocks are partitioned into nonoverlapping sub-block with free revolution factors. This turn factor creates time area information with the least amplitude.[26-27]

In the PTS approach, the recurrence area grouping which is addressed by vectors, Xm , m= 1,2,3,… .., M is apportioned into M disjoint sub-block of equivalent size in X information block., which can be addressed as

$$X = \sum_{m=1}^{M} Xm \quad (5)$$

Where all the subcarrier places that introduced by one more block are is set to nothing, so the amount of all the sub-blocks is the first sign [27-30]. Then, at that point, the subblocks X are changed into time-space halfway send succession by utilized Inverse Discrete Fourier Transform activity, which can communicated as

$$Xm = \sum_{m=1}^{M} IDFT\{Xm\} \quad (6)$$

The proportion of the pinnacle power and the mean power addresses the PAPR of the OFDM signal x(n) and is communicated as.

$$PAPR = \frac{\max\{|x(n)^2|\}}{E\{|x(n)^2|\}} \quad (7)$$

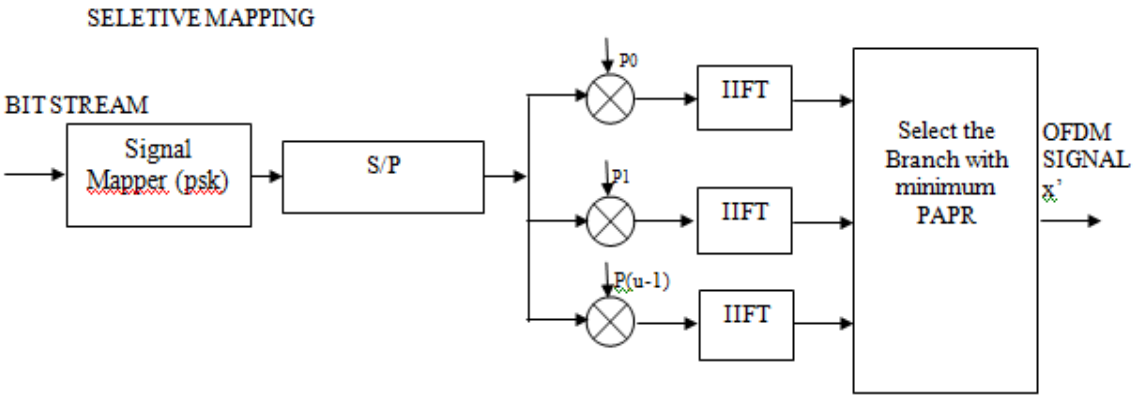

Fig. 2. Block Diagram of SLM Technique

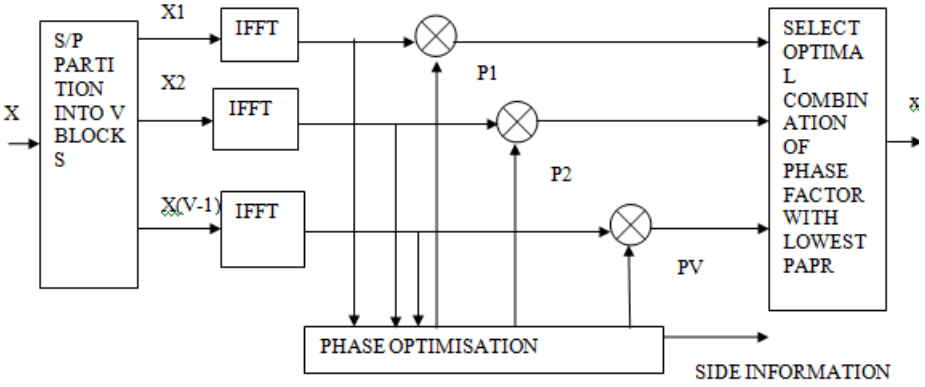

Fig. 3. Block diagram of PTS Technique

Cumulative distribution function (CCDF) [19] is utilized to gauge the PAPR of the OFDM flags and is communicated as the likelihood that the PAPR of an OFDM signal surpasses a particular limit worth of PAPR that is given by

$$CCDF(y0) = Prob\{PAPR > y0\} \quad (8)$$

- Advantage:

A.Less bending is presented.

B. Less complicated.

Drawbacks:

A.Side data is required.

B. Corrupt BER execution.

C. Include complex vector aggregates at Tx

V. Simulation Results and Discussion

A graph of carrier frequency's magnitude which compares the IFFT binary length and IFFT modulation index in terms of magnitude and conjugate carriers. Considering 1024 as IFFT binary length, the carrier frequency magnitude varies from 0 to 1, as for some points, the value will be zero and for some points, it will be 1. It became 1 when the phase changes from -180 degrees to +180 degrees. Figure 4(a,b,c,d,e,f) depicts the simulated results of OFDM system incorporated to 5G for efficient usage of energy.

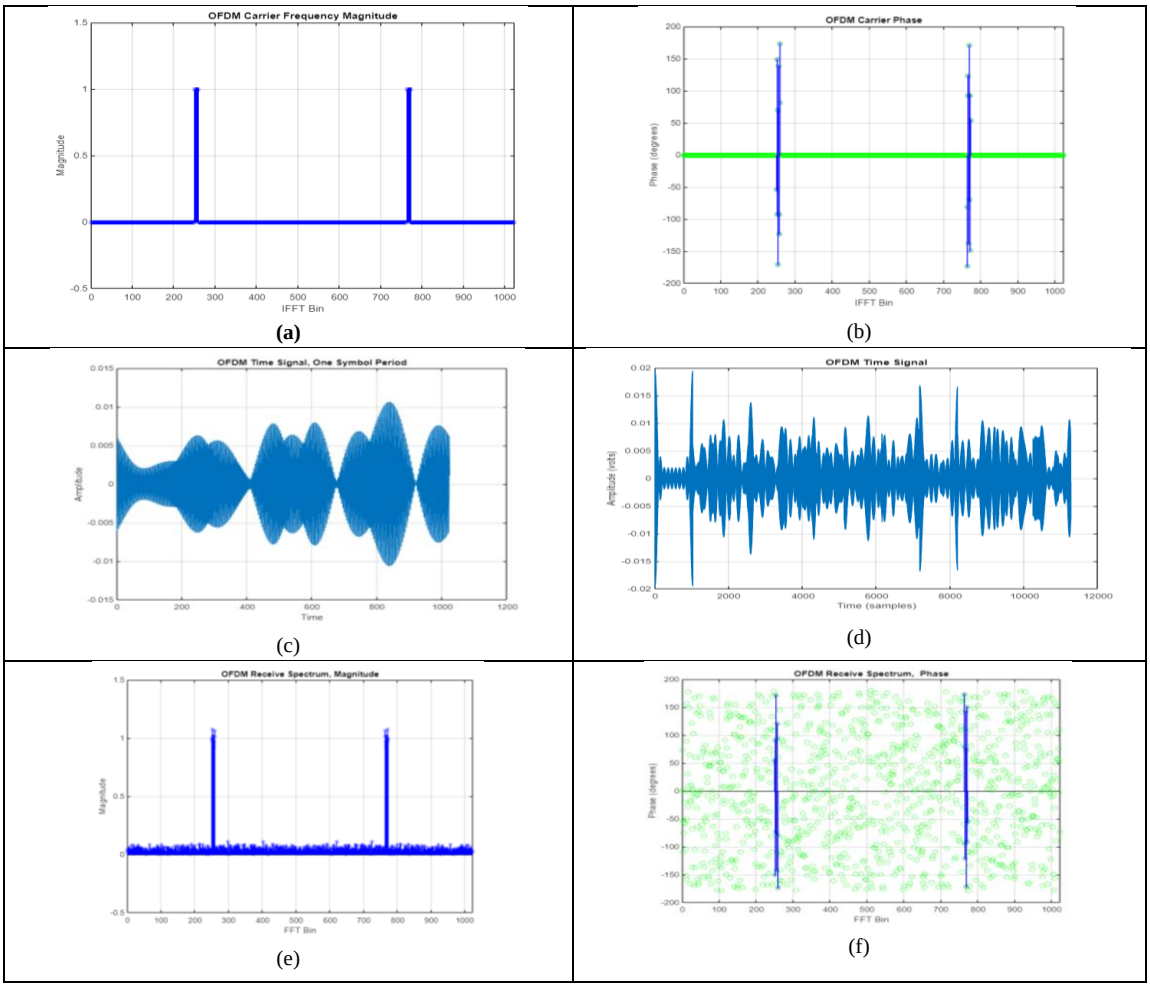

Fig. 4. (a,b,c,d,e,f) 5G incorporated OFDM System Response for efficient usage of energy.

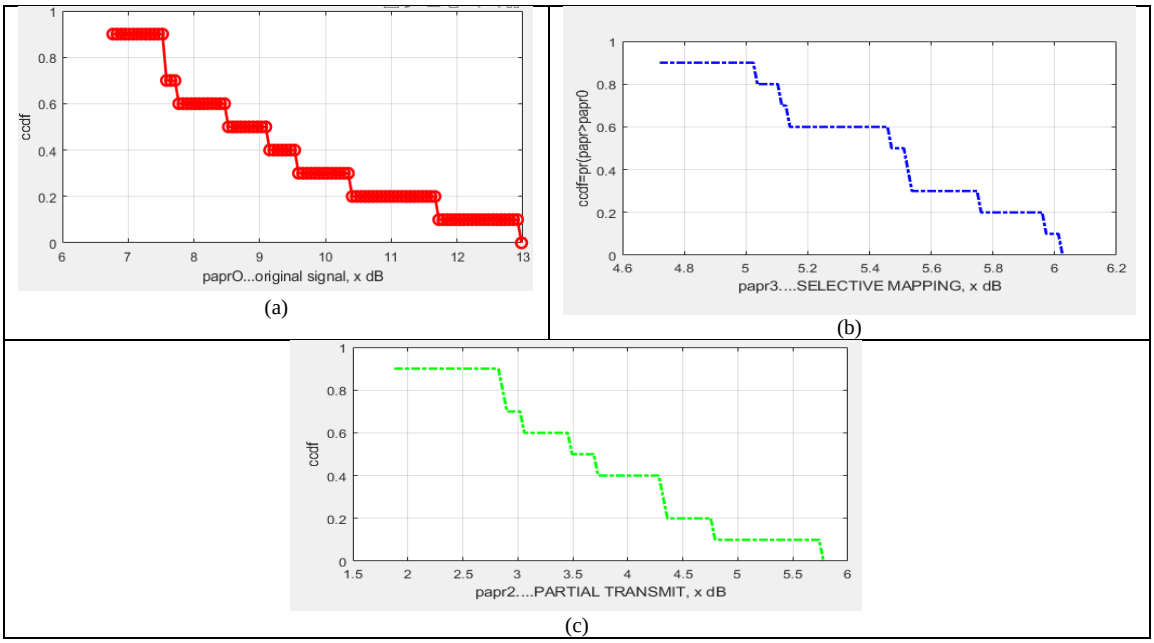

Fig. 5. (a,b,c) PAPR reduction vs CCDF for ,PTS and SLM Weighted OFDM

Original OFDM signal,PTS signal,SLM signal in terms of gain and CCDF of the respective received signal.Considering 1024 as IFFT binary length, the gain of OFDM received signal,SLM and PTS with the CCDF function of all received signals and the bit error is compared . Figure 5(a,b,c) gives a comparison between the PAPR reduction vs CCDF for ,PTS and SLM Weighted OFDM PAPR reduction techniques for the signals considered.

VI. COMPARATIVE ANALYSIS BETWEEN THE TECHNIQUES

The below table is the comparison of the gain with respect to CCDF between received OFDM signal,PTS signal and SLM signal.With the above comparison,it can inferred that PTS is more efficient than SLM and original received signal because the ratio between maximum PAPR and the average PAPR is very less in comparison to SLM. Table 1. discuss about the parametric analysis of the technique used.

TABLE I. PARAMETRIC COMPARISON BETWEEN PTS AND SLM TECHNIQUES USED FOR ENERGY EFFICIENCY IN 5G SYSTEM

No. Of Iteration	Ccdf=Pr(Papr>Papr0)	Original Signal	PTS	SLM
		GAIN(In dB)		
1	0.9	7.5222	1.9164	4.7339
2	0.8	7.553	2.8621	5.0370
3	0.7	7.5874	2.9015	5.1160
4	0.6	7.7729	3.0591	5.1421
5	0.5	8.5255	3.4926	5.4849
6	0.4	9.3410	3.7290	5.5244
7	0.3	9.9055	4.3201	5.5376
8	0.2	10.7836	4.6748	5.7616
9	0.1	11.7245	4.8324	5.9724
10	0	12.9789	5.7781	6.0251

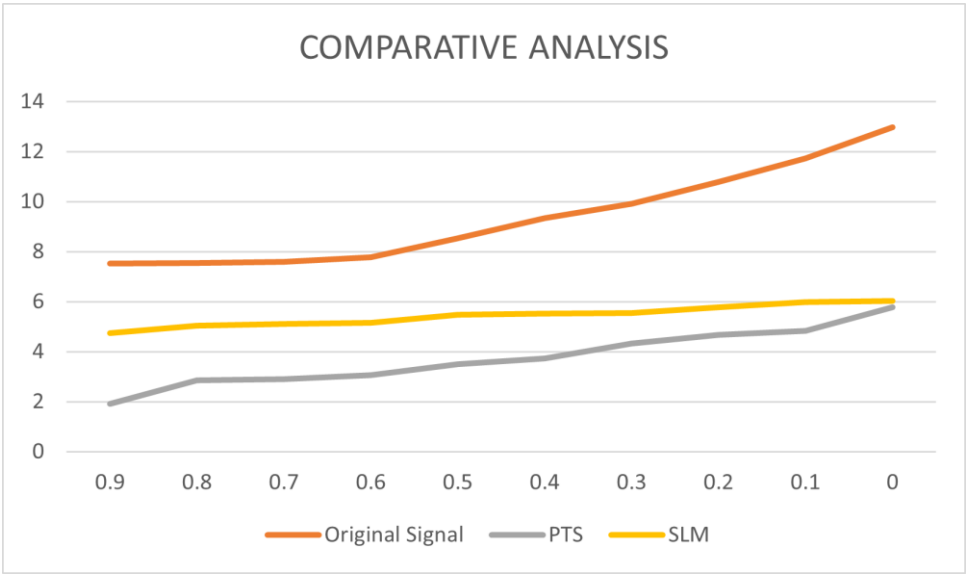

Fig. 6. Comparison between Original signal,PTS,SLM

VII. CONCLUSION:

The PAPR reduction project comprises numerous effective techniques. However, most commercial system implementations favor signal distortion techniques with affordable complexity such as iterative clipping and filtering, despite their negative impact on transmission BER . On the other hand, distortionless techniques suffer unrealistic computational complexity, especially upon employing a large number of subcarriers. A PAPR reduction technique that maintains the effectiveness and simplicity of signal distortion techniques without degrading system BER. These gains are achieved in return for a slight (and controllable) reduction. However, we argue that although signal distortion techniques do not send side information, their degraded BER performance will probably entail applying channel coding in order to preserve the integrity of data. Hence, effectively, the data rate would be significantly reduced, in addition to the impact on computational complexity associated with the decoding process.SLM & PTS both schemes utilize several IFFTs instead of one and choose one signal from a multiplicity of transmit sequences. SLM-OFDM and PTS-OFDM can work with arbitrary numbers of subcarriers and any symbol mapping scheme. SLM outperforms PTS in terms of PAPR reduction vs. redundancy, but PTS is considerably better with respect to PAPR reduction vs. additional system complexity.

REFERENCE

[1] D. Na and K. Choi, "Low PAPR FBMC," IEEE Transactions on Wireless Communications, vol. 17, no. 1, pp.182–193, 2018.

[2] H. Liang and H. Jiang, "The modified artificial bee colony-based SLM scheme for PAPR reduction in OFDM systems," in 2019 Int. Conf. on Artificial Intelligence in Information and Communication (ICAIIC). Okinawa, Japan, 504–508, 2019.

[3] Q. Zhang, H. Chen, J. Luo, Y. Xu and C et al., "Wu etal, Chaos enhanced bacterial foraging optimization for global optimization," IEEE Access, vol. 6, pp. 64905–64919, 2018.

[4] F. Sandoval, G. Poitau and F. Gagnon, "Hybrid peak-to-average power ratio reduction techniques: Review and performance comparison," IEEE Access, vol. 5, pp. 27145–27161, 2017.

[5] K. Arun, "Novel hybrid PAPR reduction technique for NOMA and FBMC system and its impact in power amplifiers," IETE Journal of Research, vol. 65, no. 5, pp. 1–17, 2019.

[6] Cho, Y.S.; Kim, J.; Yang, W.Y.; Kang, C.G. MIMO-OFDM Wireless Communications with MATLAB; John Wiley & Sons: Hoboken, NJ, USA, 2010.

[7] Dai, L.; Wang, Z.; Yang, Z. Time-frequency training OFDM with high spectral efficiency and reliable performance in high-speed environments. IEEE J. Sel. Areas Commun. 2012, 30, 695–707. [CrossRef]

[8] Fathy, S.A.; Ibrahim, M.; El-Agooz, S.; El-Hennawy, H. Low-Complexity SLM PAPR Reduction Approach for UFMC Systems. IEEE Access 2020, 8, 68021–68029. [CrossRef]

[9] Almutairi, A.F.; Al-Gharabally, M.; Krishna, A. Performance analysis of hybrid peak to average power ratio reduction techniques in 5G UFMC systems. IEEE Access 2019, 7, 80651– 80660. [CrossRef]

[10] Wang, Y.; Zhang, R.; Li, J.; Shu, F. PAPR Reduction Based on Parallel Tabu Search for Tone Reservation in OFDM Systems. IEEE Wirel. Commun.Lett. 2019, 8, 576–579. [CrossRef]

[11] Kamurthi, R.T. Review of UFMC Technique in 5G. In Proceedings of the 2018 International Conference on Intelligent Circuits and Systems (ICICS), Phagwara, India, 19–20 April 2018; pp. 115–120.

[12] Valluri, S.; Mani, V. A novel approach for reducing complexity in the SLM-GFDM system. Phys. Commun. 2019, 34, 188–195. [CrossRef]

[13] Pradhan, D., & C, P. K. (2020) 'RF-Energy Harvesting (RF-EH) for Sustainable Ultra-Dense Green Network (SUDGN) in 5G Green Communication', Saudi Journal of Engineering and Technology ISSN 2415-6272 (Print) |ISSN 2415-6264 (Online, 5(6), pp.258- 264 http://doi.org/10.36348/sjet.2020.v05i06.001

[14] D. Pradhan, P. K. Sahu, A. Dash and H. M. Tun, "Sustainability of 5G Green Network toward D2D Communication with RF- Energy Techniques," *2021 International Conference on Intelligent Technologies (CONIT)*, 2021, pp. 1-10, https://doi.org/10.1109/CONIT51480.2021.9498298

[15] Praneeth P. Jain, Pradeep R. Pawar, Prajwal Patil, Devasis Pradhan, (2019). Narrowband Spectrum Sensing in Cognitive Radio: Detection Methodologies. *International Journal of Computer Sciences and Engineering*, 7(11), 105-113. https://doi.org/10.26438/ijcse/v7i11.105113

[16] Pradhan D., Rajeswari (2021) 5G-Green Wireless Network for Communication with Efficient Utilization of Power and Cognitiveness. In: Raj J.S. (eds) International Conference on Mobile Computing and Sustainable Informatics. ICMCSI 2020.EAI/Springer Innovations in Communication and Computing.Springer, Cham. https://doi.org/10.1007/978-3-030-49795-8_32

[17] Pradhan, D., & C, P. K. (2019).Effectiveness of Spectrum Sensing in Cognitive Radio toward 5G Technology. Saudi Journal of Engineering and Technology, Dec, 4(12), 473- 785. https://doi.org/10.36348/sjeat.2019.v04i12.001

[18] Pradhan, D. (2018). Massive MIMO Technique Used For 5Th Generation System with Smart Antenna. International Journal of Electrical, Electronics And Data Communication (IJEEDC), 6(7), 81-87.

[19] Pradhan, D., K.C, Priyanka., & Rajeswari. (2021) 'SDR Network & Network Function Virtualization for 5G Green Communication (5G-GC)' , in Mangesh Ghonge, Ramchandra Sharad Mangrulkar, Pradip M Jawandhiya, Nitin Goje (ed.) *Future Trends in 5G and 6G Challenges, Architecture, and Applications. : CRC Press - Taylor & Francis Group*, pp. ISBN 9781032006826, https://doi.org/10.1201/9781003175155

[20] Pradhan, D., Sahu, P.K., Rajeswari, Tun, H.M. (2022). A Study of Localization in 5G Green Network (5G-GN) for Futuristic Cellular Communication. In: Sikdar, B., Prasad Maity, S., Samanta, J., Roy, A. (eds) Proceedings of the 3rd International Conference on Communication, Devices and Computing. Lecture Notes in Electrical Engineering, vol 851. Springer, Singapore. https://doi.org/10.1007/978-981-16-9154-6_43

[21] Pradhan, D., & Dash, A. (2020) 'An Overview of Beam Forming Techniques Toward the High Data Rate Accessible for 5G Networks', *International Journal of Electrical, Electronics and Data Communication*, ISSN(p): 2320-2084, ISSN(e): 2321-2950 , 8(12), pp. 1-5.

[22] Pradhan, D., Sahu, P. K., Goje, N. S., Ghonge, M. M., Tun, H. M., Rajeswari, R., & Pramanik, S. (2022). "Security, Privacy, Risk, and Safety Toward 5G Green Network (5G-GN)," in Cyber Security and Network Security , Wiley, 2022, pp.193-216, https://doi.org/10.1002/9781119812555 . ch9.Security, Privacy, Risk, and Safety Toward 5G Green Network (5G-GN). Cyber Security and Network Security, 193-216.

[23] Pradhan, D., Sahu, P.K., Ghonge, M.M., Rajeswari, Tun, H.M. (2022). Security Approaches to SDN-Based Ad hoc Wireless Network Toward 5G Communication. In: Ghonge, M.M., Pramanik, S., Potgantwar, A.D. (eds) Software Defined Networking for Ad Hoc Networks. EAI/Springer Innovations in Communication and Computing. Springer, Cham. https://doi.org/10.1007/978-3-030-91149-2_7

[24] W. M. Oo, H. M. Tun, T. M. Nway, D. Pradhan, P. K. Sahu and Z. M. Naing, "Design, Analysis and Fabrication of Dual Band Microstrip Patch Antenna for (L2) Band GPS and WiFi Applications," *2022 International Conference for Advancement in Technology (ICONAT)*, 2022, pp. 1-5, https://doi.org/10.1109/ICONAT53423.2022.9725872 ..

[25] H. M. Tun, Z. T. Thu Lin, D. Pradhan and P. K. Sahu, "Slotted Design of Rectangular Single / Dual Feed Planar Microstrip Patch Antenna for SISO and MIMO System," *2021 International Conference on Electrical, Computer and Energy Technologies (ICECET)*, 2021, pp. 1-6, https://doi.org/10.1109/ICECET52533.2021.9698738 .

[26] Pradhan, D., K.C, Priyanka., & Rajeswari (2021) 'GREEN- Cloud Computing (G-CC) Data Center and its Architecture toward Efficient Usage of Energy', in Mangesh Ghonge, Ramchandra Sharad Mangrulkar, Pradip M Jawandhiya, Nitin Goje (ed.) *Future Trends in*

5G and 6G Challenges, Architecture, and Applications. : CRC Press - Taylor & Francis Group, pp. ISBN 9781032006826.https://doi.org/10.1201/9781003175155

[27] Zhongpeng Wang, "Reduction PAPR of OFDM Signals by Combining SLM with DCT Transform", Hangzhou, China, Int. J. Communications, Network and System Sciences, 2010, 3, 888-892.

[28] Xinchun Wu, Jinxiang Wang, Bin Zhou, Zhigang Mao and Zhiqiang Gao, "Companding schemes based on transforming signal statistics into trigonal distributions for PAPR reduction in OFDM systems", Harbin, People's Republic of China ,Int. J. Commun. Syst. 2011.

[29] Jung-Chieh Chen, Member, IEEE, Min-Han Chiu, Yi-Syun Yang, and Chih-Peng Li, Member, IEEE, "A Suboptimal Tone Reservation Algorithm Based on Cross-Entropy Method for PAPR Reduction in OFDM Systems", VOL. 57, NO. 3, SEPTEMBER 2011

[30] Jawhar, Y. A., Audah, L., Taher, M. A., Ramli, K. N., Shah, N. S. M., Musa, M., & Ahmed, M. S. (2019). A review of partial transmit sequence for PAPR reduction in the OFDM systems. IEEE Access, 7, 18021-18041.