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Improving the Software Privacy in the OFDM 5G Communication Integrated with License Key in the Hardware Communication Parameters

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Abstract: Over several decades, wireless multi-media applications demand for higher data rate information transmission which exhibits the drastic advancement in the connectivity, mobility and scalability of the network. The user of wireless comprises to fulfill the requirement of users with the problem of limited available Radio frequency (RF) for the varying signal strength in the multipath fading system. However, the 5G wireless communication technology uses the OFDM technology for effective information transmission. Even though the OFDM system exhibits the improved performance in terms of delay, fairness and maximization of the throughput. The conventional OFDM scheme subjected to challenge of ICI and license key. It is necessary to reduce the license key in the OFDM signal with technique such as License Key Partial Transmit sequences (LKPTS), Clipping, Selective Mapping (SLM) and block coding. The conventional technique exhibits the reduction in license key for the higher signal transmit power, BER and higher computational complexity. Among different license key reduction scheme LKPTS is flexible and effective for the varying number of subcarriers in the suitable modulation scheme. In this paper developed a modified partial transmit sequence (MLKPTS) for the reduction of license key in the OFDM signal. In the proposed MLKPTS scheme the sequences are trained based on the superimpose of the OFDM signal for resource allocation. The developed MLKPTS scheme uses the low band and high band estimated Discrete Wavelet transform (DWT). The MLKPTS uses the pulse shaping and interleaving for the selection of the sub carriers in the signal sequences. The pulse shapes are computed and evaluated based on the cyclic drift in the signal pulse sequences. The developed PAR computes the transmitted signal amplitude based on the in-phase and quadrature phase components. The simulation analysis expressed that the proposed MLKPTS scheme significantly reduces the license key in the OFDM signal sequences.

Keywords: *5G communication, license key, Discrete Wavelet transform, OFDM*

1. Introduction

In recent year, wireless communication is emerging field in provision of the wireless services. The wireless communication technology evolved from first to fifth generation system. The developed system supports multidimensional high-speed data communication [1]. The system has been adopted in the different applications such as wireless local area networks (WLANs), and worldwide interoperability for microwave access (WiMax). The emerging wireless technology uses the 5th generation with the incorporation of the Orthogonal Frequency Division Multiplexing (OFDM) to achieve higher capacity of data and spectral efficiency [2]. OFDM signal integrates with translation of the frequency selective channel through inter symbol interference (ISI) for the narrow band channel. OFDM signal comprises of the numerous standard for the transmission of the WLAN, WiMAX and Digital Audio/Video Broadcasting (DAB/ DVB). With implementation of the WLAN IEEE 802.11a the data rate provides speed of 2Mbps and IEEE 802.11 b/g provides the data transfer rate of 54Mbps [3]. In future, wireless communication demands for the WLAN data transfer rate of 100Mbps. OFDM system effectively utilizes the available spectrum based on the sub channel availability with the transmission of the information symbol those are transmitted parallely in wireless channel. OFDM is emerged to overcome the problem associated with the Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA) [4]. In OFDM sequence the sequence of subcarrier are classified orthogonally those are multiplexed using TDMA signal multiplexed. In TDMA sequence overhead is changed based on the slotted time duration of each channel. The spectrum in each carrier signal is evaluated based on the central frequencies in the system carrier. The resulted signal does not have any interference between carrier signal. The carrier signal FDMA overhead are evaluated with narrow bandwidth of the signal base don the symbol rate and symbol period [5].

In OFDM process with the 5G technology the delay spread are

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longer than the usual and leads to higher ISI. The OFDM signal comprises of the tolerance at the higher rate with delay spread in multipath with synchronization of the signal between sender and receiver to achieve subcarrier orthogonality. With the oscillator is estimated based on the evaluation of mismatch between transmitter and receiver with the Doppler shiftc [6]. Through the incorporation of the CFO the OFDM system subjected to the Inter Carrier Interference (ICI). The OFDM symbol is subjected to advantage for the time-variant channel with the carrier frequency offset. The variation in the sub carrier of the OFDM siganal are closely associated with OFDM. The variation in the orthogonality of the synchronization frequency degrades the complete performance of the OFDM symbol [7]. Additionally, within OFDM system cyclic prefix are included with the overhead rate for the different OFDM system. At different instances of the time of the sub-carrier symbol are coherently related for the high peaks those resulted in the increased Peak-to-Average Power Ratio (LICENSE KEY). In conventional OFDM process with single carrier modulation high license key is highly affects the OFDM [8].

This paper presented a modified LKPTS scheme for the reduction of LICENSE KEY in the OFDM system. The proposed scheme comprises the DWT scheme integrated with the interleaving for the reduction of the OFDM signal. The developed MLKPTS scheme uses the computation of the subcarrier estimation in the sub-blocks with the estimation of the in-phase and quadrature components in the OFDM signal. The MLKPTS evaluates the low band and high band value in the OFDM signal with an estimation of the signal in the carrier sub-blocks. The experimental analysis stated that the developed MLKPTS scheme ~19% minimizes the LICENSE KEY in the OFDM signal.

2. Related Works

The deployed OFDM signal with 5G technology comprises of the frequency-selective fading channel for the large number of subchannels for equalization of the channel to reduce ISI, higher data rate and decoding of the symbol. The large number of subcarrier subjected to the dynamic signal range for the high LICENSE KEY. In [15] constructed a side-lobe suppression for the cancellation carriers (CC) based on insertion. The developed CC modulates the complex weighted factor for the side-lobe optimization in the transmitted signal. With implementation of the radiation in the out-of-band for the degradation in the performance of the system. With minimization of the side-lobe the guard interval (GI) is transmitted within the signal spectrum with reduction of GI. The developed scheme exhibits advantage of increased LICENSE KEY with the reduced BER performance. In [16] developed a modified repeated clipping based filtering (RCF) for the every tone distortion in the OFDM signal. The developed technique uses the RCF with bounded distortion (RCFBD) to recursion in the signal number. The developed RCFBD effectively minimizes the LICENSE KEY reduction with minimized error rate. Similarly, in [17] constructed a power re-growth approach with the limited power based on the HIPERLAN 2. In the developed scheme out-of-band computation is exhibited for the peak signal re-growth. The developed approach comprises of the introduced DFT masking for the distortion without in-band those affect the transmitter clipping based on computation of error characteristics with reduced multipath loss.

In [18] developed an efficient license key reduction scheme combination of the Carrier Interferometry (CI) with spreading of code and signal with peak-windowing employed with the Clipping/ Filtering. In CI signals employed with the carrier exhibits the additional coherent for the other part of signal. The develop pseudo-orthogonal between time domain signal are evaluated with the estimation of the relationship between variables. The complexity in the receiver side is evaluated with the coding scheme, SLM and LKPTS combined with the CI. The defined clipping scheme is effective and suitable for the combination of the CI due to higher receiver complexity. The implemented technique exhibits the higher BER with the increases in Eb/No as 1dB for the same BER in the OFDM signal. The proposed scheme [19] presented a license key reduction scheme with the OOB with comparative analysis. The developed OOB scheme comprises of the HPA back-off algorithm to achieve the desire adjacent channel leakage ratio (ACLR) with effective license key reduction. The implementation of the nonlinear companding with exploitation of the statistical distribution of the OFDM transmitted signal. The developed companding signal effectively minimizes the license key with peak signal compressing and expanding of the small signal through maintenance of the average power based on the consideration of parameters.

3. Network Model

In the OFDM modulation scheme the proposed Modified LKPTS (MLKPTS) integrated with the DWT for the computation of the lower and upper band signal in the channel network. The data block for the symbol data N represented as $[x_n = n = 0,1, \dots, N-1]$ with modulating the every subcarrier symbol set as $[f_n = n = 0,1, \dots, N-1]$ for the N number of subcarriers. The orthogonality of the subcarrier N is represented as $f_n = n\Delta f$ where $\Delta f = \frac{1}{\Delta t}$ for the symbol period of T. The signal baseband $x(t)$ for every block. The coding inclusion scheme for the every system for each 1-bit for transmission of the signal in both cosine and sine is represented as in equation (1)

$$g_n(t) = \sqrt{\frac{2S_e}{D_s}} \cos\left(2\pi f_c t + (2n-1)\frac{\pi}{4}\right), n = 1,2,3,4 \tag{1}$$

Here, $g_n(t)$ represents the time of the base signal, S_e denotes the energy of the symbol; the duration of the symbol is denoted as D_s, where, f_c represented a the signal of baseband symbol. With the MIMO OFDM the signal comprises of the 4 phases with the signal space with the computation of unit function represented as in equation (2) and (3)

$$\varphi_1(t) = \sqrt{\frac{2}{D_s}} \cos 2\pi f_c t, \quad 0 \le t \le T \tag{2}$$

$$\varphi_2(t) = \sqrt{\frac{2}{D_s}} \sin 2\pi f_c t, \quad 0 \le t \le T \tag{3}$$

In above equation (2) and (3) the in-phase and quadrature point in the symbol is represented as $\varphi_1(t)$ and $\varphi_2(t)$. The constellation points in the signal at 4 point are stated as in equation (4)

$$\left(\pm\sqrt{\frac{S_e}{2}}, \pm\sqrt{\frac{S_e}{2}}\right) \tag{4}$$

In the above stated equation the signal factor defines the total system power represented as ½ those are partitioned between 2 carriers equally. At receiver end, the carrier-phase factor are demodulated for the successive 2 receivers based on the input data. The transmisteed symbol sequence for the PSF (Point Spread

Function) is denoted as $p_t(t)$ for the receiver antenna at the filtering component stated as $p_r(t)$. The channel composite in the symbol denoted as $H(t)$ for the time domain signal at the receiver $i_{R\,th}$ antenna presented as in equation (5)

$$h_{iR,iT}(n) = \sum_{i_T=1}^{N_T} h_{iR,iT}(n) \otimes x_{iT} + N \quad (5)$$

Here, in above equation (5) the temporal region for the uncorrelated place is denoted as N with the time-domain transmit in the noise represented as x_{iT} in the i[th] antenna. At the receiver side, the Inter Symbol Interference (ISI) is eliminated with the MIMO – OFDM along with the Inverse Fast Fourier Transform (IFFT). In the receiver side, through consideration of the time-domain factor complex operation is performend to increases the system execution speed, precision and flexibility. At the N – point operation in the receiver the computed IFFT is expressed as in equation (6)

$$u(n) = \frac{1}{N} \sum_{n=1}^{N-1} U(k) e^{\frac{-j\pi kn}{N}}, n = 0,1,\ldots.., N-1 \quad (6)$$

Where N denoted as the transformation in the data frame for the signal point is denoted as $U(k)$ for the k[th] point FFT output frequency stated as k=0,1,…….., N-1. With FFT analysis the signal transmuted are utilized for analysis in the receiver domain time domain. The mathematical formulation of the FFT is presented in equation (7) as follows

$$U(k) = \sum_{n=1}^{N-1} u(n) e^{\frac{-j2\pi kn}{N}}, k = 0,1,\ldots.., N-1 \quad (7)$$

The signal transmitted over the multipath channel addition to the AWN is characteristics are considered for analysis. The system performance in the system is represented with the Gaussian distribution n distributed with the rando stationay point with the average mean of 0 and formulated vector in the identical component are defined in equation (8)

$$n = n_p \times (N(0,1)) + i \times N(0,1) \quad (8)$$

Where, n_p denotes the signified noise power, message signal same length is denoted as $(N(0,1))$ comprises of the random variables in normal/Gaussian.

4. Results and Discussion

The examination is based on the evaluation of the security improvement with the license key privacy with the MIMO-OFDM is performed in the MATLAB. The simulation setting for the proposed LKPTS model is presented in table 1.

Table 1: Simulation Setting

Simulation parameters	Type/Values
Total subcarriers (N)	64, 128, 256, 512, 1024
Total Subblocks (V)	2, 4, 8,16
Oversampling factor (L)	4
Subblock partitioning scheme	Adjacent
Number of antennas(Mt)	1 and 2
Modulation scheme	QPSK
Phase weighting factor (b)	+1, -1, +j, -j

The license key performance for OFDM system using modified LKPTS technique and modified LKPTS with interleaving technique are simulated with fixed subblocks V=4 and their performances are compared in Figure 1. It is observed that license key values of OFDM without any license key reduction technique (normal OFDM), modified LKPTS and modified LKPTS with interleaving technique are 10.8 dB, 9.4 dB and 7.6 dB respectively at CCDF of 3 10. The license key reduction performance in modified LKPTS with interleaving technique increased by 19% when compared with modified LKPTS.

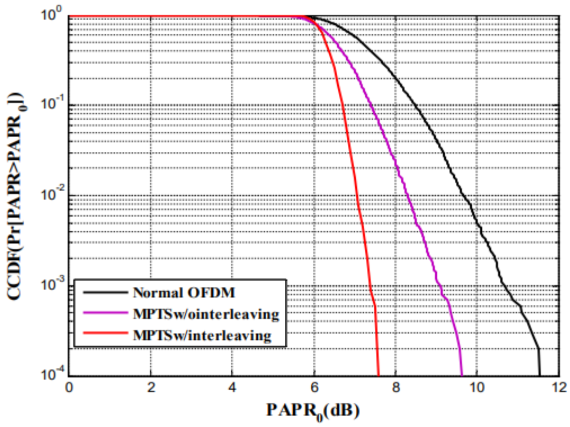

Figure 1: Comparison of license key

In Figure 2 shows that the license key performance of modified LKPTS with interleaving technique for different subcarriers of size 64, 128, 256, 512 and 1024 with subblocks V=4 in OFDM systems. It is evident that the LICENSE KEY values of 6.4 dB, 6.9 dB, 7.6 dB, 7.8 dB and 8.3 dB are obtained for different subcarriers of size 64, 128, 256, 512 and 1024 respectively at CCDF of 10-3. This simulation result shows that with increase in the number of subcarriers, the license key reduction performance is degraded.

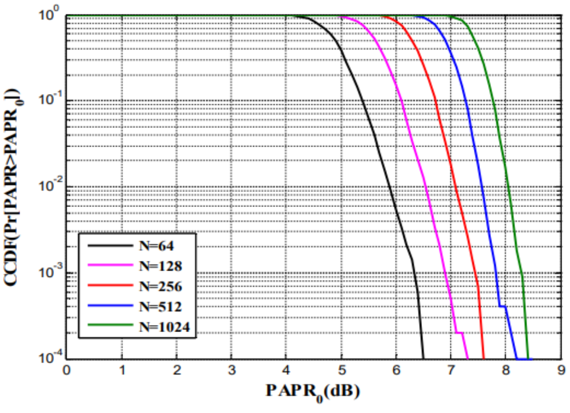

Figure 2: license key in different N values

In order to obtain high data rate, large number of subcarriers are needed which in turn increases the license key and computational complexity. To overcome this limitation, the size of the subblocks can be varied with fixed moderate subcarrier size. The performance of modified LKPTS with interleaving technique in OFDM system for N=256 subcarriers is analyzed for various subblock sizes of 2, 4, 8 and 16 and it is illustrated in Figure 6. From this figure, it is found that the license key values for the various subblocks size of 2, 4, 8 and 16 are 9 dB, 7.6 dB, 6.5 dB and 6.3 dB respectively at CCDF of 10-3 . It shows that the performance of license key reduction is increased when the number of subblocks is increased.

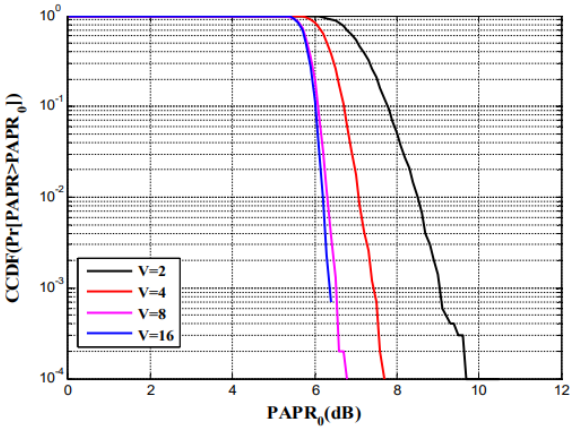

Figure 3: Comparison of license key at different V values

The license key performance of MIMO-OFDM system with two transmitting antennas is analysed using modified LKPTS without interleaving and with interleaving techniques by simulation with fixed subblocks V=4. The simulation results are depicted in Figure 3. From this figure it is found that license key values of MIMO-OFDM without any license key reduction, using modified LKPTS and modified LKPTS with interleaving techniques at CCDF of 10-3 are 10.8 dB, 9.4 dB and 7.6 dB respectively. Thus through simulation study it is verified that modified LKPTS with interleaving technique is beneficial providing considerable improvement of 19% in license key reduction compared to that of modified LKPTS. The advantage of the proposed scheme for STBC MIMO-OFDM is most suitable for fast fading channels and license key values are same in comparison to OFDM system.

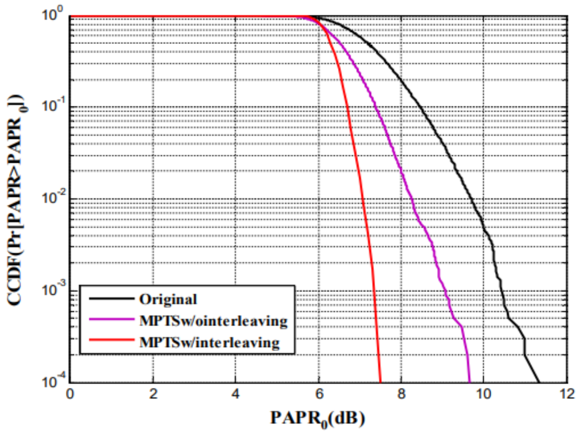

Figure 4: Comparison of OFDM subcarrier

In Figure 4 displays the license key reduction performance of modified LKPTS with interleaving technique for different subcarriers of size 64, 128, 256, 512 and 1024 keeping subblock V=4 in MIMO-OFDM with Mt = 2. It can be observed that the LICENSE KEY values of 6.4 dB, 6.9 dB, 7.6 dB, 7.8 dB and 8.3 dB are obtained for different subcarriers of size 64, 128, 256, 512 and 1024 respectively at CCDF of 10-3 .

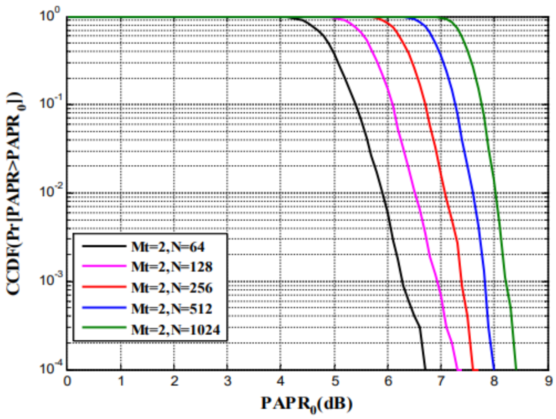

Figure 5: Comparison of MLKPTS interleaving

To increase license key reduction at reduced computational complexity, fixed carrier size and different subblock sizes are considered. Figure 5 illustrates the performance of modified LKPTS with interleaving technique in MIMO-OFDM systems, considering the Mt=2 transmit antennas with number of subcarriers N=256 for different subblock sizes of 2, 4, 8 and 16. It can be seen that the LICENSE KEY reduction performance for the different subblocks size of 2, 4, 8 and 16 are 9 dB, 7.6 dB, 6.5 dB and 6.3 dB respectively at CCDF of 3 10. It can be concluded that the license key values are further found to be decreased as the number of subblocks are increased.

5. Conclusion

This paper presented a modified LKPTS scheme integrated with the DWT based interleaving technique for the reduction of license key in OFDM system. The developed scheme increases the subblocks for the subcarriers in the fixed range. Also, the proposed MLKPTS scheme increases the subblocks with the reduced computational complexity. Through neighbourhood search computation the optimal sets are derived for the optimum set of the features to exhibit the OFDM signal order with the reduced license key minimal than the threshold value of the OFDM signal. The simulation analysis expressed that the developed MLKPTS scheme improves the OFDM performance with integration of the OFDM schemes. The developed scheme effectively decreases the license key reduces the license key of 19% compared with the conventional interleaving technique. In future the developed model can applied with the channel estimation of the multiple users in the network. The analysis is based on the computation of the license key in the Primary and Secondary User in the wireless communication.

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