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IMPLEMENTATION PAPR CODE FOR OFDM SYSTEM

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I. INTRODUCTION TO OFDM

OFDM

OFDM is an acronym that stands for Orthogonal Frequency Division Multiplexing. Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier transport technology for high data rate communication system. The OFDM concept is based on spreading the high speed data to be transmitted over a large number of low rate carriers. The carriers are orthogonal to each other and frequency spacing between them are created by using the Fast Fourier transform (FFT). OFDM originates from Frequency Division Multiplexing (FDM), in which more than one low rate signal is carried over separate carrier frequencies (Table). In FDM, separation of signal at the receiver is achieved by placing the channels sufficiently far apart so that the signal spectrum does not overlap. Of course, the resulting spectral efficiency is very low as compared with OFDM, where a comparison is depicted in Fig.

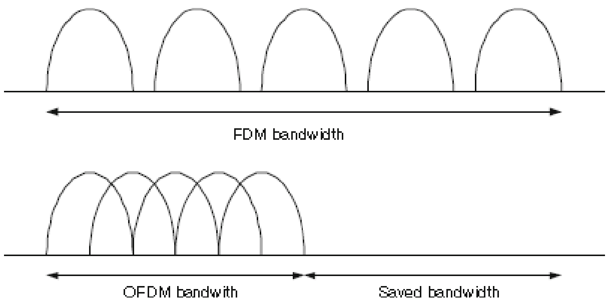


Fig Comparison of OFDM with FDM

FDM is first utilized to carry high-rate signals by converting the serial high rate signal into parallel low bit streams. Such a parallel transmission scheme when compared with high-rate single carrier scheme is costly to build. On the other hand, high-rate single carrier scheme is more susceptible to inter symbol interference (ISI). This is due to the short duration of the signal and higher distortion by its wider frequency band as compared with the long duration signal and narrow bandwidth sub channels in the parallel system. Fig. shows an analogy of OFDM against single carrier and FDM in terms of spectral efficiency.

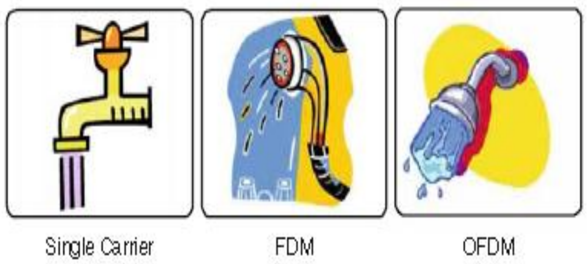


Fig Comparison of OFDM over FDM and single-carrier systems. OFDM and FDM are resilient to interference, since flow of water can be easily stopped in single-carrier systems. OFDM is more spectral efficient than FDM, since it utilizes the surface effectively with adjacent tiny streams.

The technique involved assembling the input information into blocks of N complex numbers, one for each sub-channel as seen in Fig. . An inverse FFT is performed on each block, and the resultant transmitted serially. At the receiver, the information is recovered by performing an FFT on the received block of signal samples. The spectrum of the signal on the line is identical to that of N separate QAM signals as seen in Fig. , where N frequencies separated by the signaling rate. Each QAM signal carries one of the original input complex numbers. The spectrum of each QAM signal is of the form $\sin(kf)/f$ with nulls at the center of the other subcarriers as seen in Fig This ensures orthogonality of subcarriers.

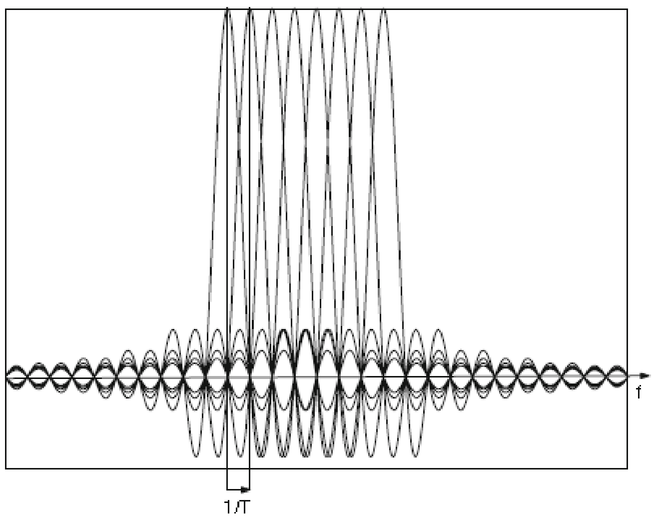


Fig OFDM spectrum for each QAM Signal

Table History of OFDM

1957 Kineplex, multicarrier HF modem

1966 Chang, Bell Labs: OFDM paper and US patent 3488445

1971 Weinstein and Ebert proposed use of FFT and guard interval

1985 Cimini described the use of OFDM for mobile communications

1985 Telebit Trailblazer Modem incorporates a 512-carrier Packet Ensemble Protocol

1987 Alard and Lasalle: Coded OFDM for digital broadcasting

1988 TH-CSF LER, first experimental Digital TV link in OFDM, Paris area

1989 OFDM international patent application PCT/FR 89/00546, filed in the name of THOMSON-CSF, Fouche, de

Couasnon, Travert, Monnier and others
1990 TH-CSF LER, first OFDM equipment field test, 34 Mbps in a 8-MHz channel,experiments in Paris area
1990 TH-CSF LER, first OFDM test bed comparison with VSB in Princeton, USA
1992 TH-CSF LER, second generation equipment field test, 70 Mbit/s in a 8-MHz channel, twin polarizations. Wuppertal, Germany
1992 TH-CSF LER, second generation field test and test bed with BBC, near London, UK
1993 TH-CSF show in Montreux SW, 4 TV channel and one HDTV channel in a single 8-MHzchannel
1993 Morris: Experimental 150 Mbit/s OFDM wireless LAN
1994 US patent 5282222, method and apparatus for multiple access between transceivers in wireless communications using OFDM spread spectrum
1995 ETSI Digital Audio Broadcasting standard EUreka: First OFDM-based standard
1997 ETSI DVB-T standard
1998 Magic WAND project demonstrates OFDM modems for wireless LAN
1999 IEEE 802.11a wireless LAN standard (Wi-Fi)
2000 Proprietary fixed wireless access (V-OFDM, Flash-OFDM, etc.)
2002 IEEE 802.11g standard for wireless LAN
2004 IEEE 802.16-2004 standard for wireless MAN (WiMAX)
2004 ETSI DVB-H standard
2004 Candidate for IEEE 802.15.3a standard for wireless PAN (MB-OFDM)
2004 Candidate for IEEE 802.11n standard for next-generation wireless LAN
2005 OFDMA is candidate for the 3GPP Long Term Evolution (LTE) air interface E-UTRA downlink.
2007 The first complete LTE air interface implementation was demonstrated, including OFDM-MIMO, SC-FDMA and multi-user MIMO uplink

II. EXPERIMENTAL AND COMPUTATIONAL

In this chapter an optimized mitigation technique of PAPR is introduced in which less complexity is required and a good tradeoff is done between the PAPR reduction and Calculation cost of selecting the Phase rotation vectors in case of Partial transmit sequence scheme. First we will define the PTS method and then we will focus on our proposed scheme. The PTS method is an efficient method but calculation cost of its phase rotation vectors is high. So a novel approach is used to minimize the calculation cost. With the help of simulation performance of the new algorithm compared to traditional algorithm in terms of PAPR reduction and system throughput is being studied to deduce important conclusions.

III. PARTIAL TRANSMIT SEQUENCE

In PTS approach, the input data block is partitioned into disjoint sub-blocks. The sub carriers in each sub block are weighted by a phase rotations. The phase rotations are selected such that the PAPR is minimized. At the receiver, the original data are recovered by applying inverse phase rotations.

Consider we have an input data block { $X_{n,n=0,1,2,.........,N}$ } is defined as a vector

$$X = [X_1, X_2, ...X_N]^T$$

The vector X is Partitioned into V disjoint sets. It is represented by vectors $\{X^v, v=1,2,3,.........,V\}$ where
$X^0=[X^1,\ldots X^{(N/V)}, ..0\ldots0\ldots0 \quad 0\ldots0]^T$
$X^v= [0\ldots.0\ldots.X^{((v-1)(N/V)+1)},\ldots\ldots.,X^{(v.(N/V))} \quad 0,\ldots0]^T$

$$X = \sum_{v=1}^{V} X^v$$

Where X^v are the sub-blocks that are consecutively located and are of equal size. In case of PAPR the scrambling is applied to each sub-block.

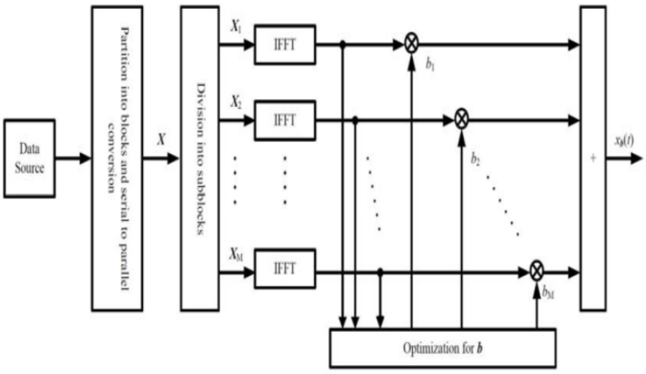


Fig a general PTS sequence

Each partitioned sub-block is multiplied by a corresponding complex phase factor, $b^v = e^{j\phi v}, v = 0,1,2,........,V$ subsequently taking its IFFT to yield

$$x = IFFT\{\sum_{v=1}^{V} b^v X^v\} = \sum_{v=1}^{V} b^v IFFT\{X^v\} = \sum_{v=1}^{V} b^v x^v$$

Where { x^v } is referred to as a partial transmit sequence (PTS). The phase vector is chosen so that the PAPR can be minimized which is shown as

$$[\tilde{b}^1,......\tilde{b}^V] = \arg\min_{[b^1,......b^V]} \left(\max_{n=0,1,2,.......,N-1} \left| \sum_{v=1}^{V} b^v x^v[n] \right| \right)$$

Then , the corresponding time-domain signal with the lowest PAPR vector can be expressed as

$$\tilde{x} = \sum_{v=1}^{V} \tilde{b}^v x^v$$

The selection of the phase factors $\{b^v\}_{v=1}^{V}$ is limited to a set of elements to reduce the search complexity. As the set of allowed phase factors is $b = \{e^{j2\pi i/W} \left| i = 0,1,......,W-1\}, W^{V-1}\right.$ sets of phase factors should be searched to find the optimum set of phase vectors. Therefore, the search complexity increases exponentially with the number of sub-blocks.

The PTS technique requires V IFFT operations for each data block and $\left\lceil \log_2 W^V \right\rceil$ bits of side information. The PAPR performance of the PTS technique is affected by not only the number of sub-blocks, V, and the number of the allowed

phase factors, W, but also the sub-block partitioning.
Proposed Optimized Reduction Scheme:

Choosing $b^v \in \{\pm 1, \pm i\}(W = 4)$ is widely used in conventional systems. We can set $b_1 = 1$ without loss of performance. Accordingly, in order to determine other weights, we need an exhaustive search for (M-1) phaserotations. In this search, W^{V-1} sets of candidate vectors onphase rotations are prepared and one of them is selected as theoptimum set of phase rotations. So from the case of conventional PTS schemes we have to compute 4^{W-1} no. of calculations for finding the phase rotation vectors. The proposed scheme provides a better solution for computation of the phase vectors. The proposed scheme is detailed below:

- Assume N_{sb} define the no. of sub-blocks into which the input data is to be partitioned.
- Define the size of the sub-carriers (N) and the Oversampling Factor for the OFDM signal.
- Define 'r', where 2^r becomes the no of times the value of v is to be calculated for finding the minimum PAPR.
- Assume b^v=1 for v=$1 : N_{sb}$.
- Find PAPR for equation (4.2) and set it as PAPR_min.
- Increment v by 1, and then again find the PAPR for equation (4.2) with the value of $b^v = -1$.
- If PAPR>PAPR_min then set the value of $b^v = 1$.
- Now update the value of PAPR_min by PAPR.
- If PAPR<PAPR_min then set the value of $b^v = 1$.
- Now continue the process until $v < 2^r$ by incrementing the value of v by one every times and going back for calculating the value of PAPR from step(7)
- When v becomes equal to 2^r, then exit the process with the set of optimal phase vectors $\tilde{b}$.

Here from the algorithm we can see that the no. of phase rotation vectors depends upon the value of 2^r where r=3,4,5,6,7,8…. However we cannot exceed the value of r after r=8 as this will not give a more change in the value of PAPR. From the PTS scheme where the no of computation were 4^{Nsb-1} we come to a result with computation equals to $2^r, r = 3,4,5,6,7,8$. So the performance of this algorithm increases as the no of sub-blocks, $N_{sb} = 4,8,16,64,128.........increases$ and we will see in the next chapter that this will minimize the PAPR up to a certain limit and that value of 'r' becomes prominent value for this algorithm.

IV. SIMULATION PLATFORM

Simulation provides a repeatable, controlled experimentation with only a modest overhead required to construct and carry out simulations. This section of the chapter provides an explanation of the implementation tool. The simulator we are going to use here is MATLAB.

MATLAB is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numeric computation. Using the MATLAB product, you can solve technical computing problems faster than with traditional programming languages, such as C, C++, and Fortran. You can use MATLAB in a wide range of applications, including signal and image processing, communications, control design, test and measurement, financial modeling and analysis, and computational biology. Add-on toolboxes (collections of special-purpose MATLAB functions, available separately) extend the MATLAB environment to solve particular classes of problems in these application areas.

MATLAB provides a number of features for documenting and sharing your work. You can integrate your MATLAB code with other languages and applications, and distribute your MATLAB algorithms and applications.

Matlab Features

- High-level language for technical computing
- Development environment for managing code, files, and data
- Interactive tools for iterative exploration, design, and problem solving
- Mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, and numerical integration
- 2-D and 3-D graphics functions for visualizing data
- Tools for building custom graphical user interfaces
- Functions for integrating MATLAB based algorithms with external applications and Languages, such as C, C++, FORTRAN, Java™, COM, and Microsoft® Excel®

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

Typical uses include:

- Math and computation
- Algorithm development
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including Graphical User Interface building

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non-interactive language such as C or Fortran. The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects, which together represent the state-of-the-art in software for matrix computation.

MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis.

MATLAB features a family of application-specific solutions called toolboxes. Very important to most users of MATLAB, toolboxes allow you to learn and apply specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others.

The MATLAB System
The MATLAB system consists of five main parts:
The MATLAB language.
This is a high-level matrix/array language with control flow statements, functions, data structures, input/output, and object-oriented programming features. It allows both "programming in the small" to rapidly create quick and dirty throw-away programs, and "programming in the large" to create complete large and complex application programs.
The MATLAB working environment.
This is the set of tools and facilities that you work with as the MATLAB user or programmer. It includes facilities for managing the variables in your workspace and importing and exporting data. It also includes tools for developing, managing, debugging, and profiling M-files, MATLAB's applications.
Handle Graphics.
This is the MATLAB graphics system. It includes high-level commands for two-dimensional and three-dimensional data visualization, image processing, animation, and presentation graphics. It also includes low-level commands that allow you to fully customize the appearance of graphics as well as to build complete Graphical User Interfaces on your MATLAB applications.
The MATLAB mathematical function library.
This is a vast collection of computational algorithms ranging from elementary functions like sum, sine, cosine, and complex arithmetic, to more sophisticated functions like matrix inverse, matrix eigen values, Bessel functions, and fast Fourier transforms.
The MATLAB Application Program Interface (API).
This is a library that allows you to write C and FORTRAN programs that interact with MATLAB. It include facilities for calling routines from MATLAB (dynamic linking), calling MATLAB as a computational engine, and for reading and writing MAT-files.
About Mat Lab Desktop
When you start MATLAB, the desktop appears, containing tools (graphical user interfaces) for managing files, variables, and applications associated with MATLAB.
The following illustration shows the default desktop. You can customize the arrangement of tools and documents to suit your needs. For more information about the desktop tools, see Desktop Tools and Development Environment.
RESULTS AND DISCUSSIONS

To perform the simulationmatlab is installed on Windows XP Operating System using Mathworks. Mathworks provides a very good simulation platform for calculation under Windows. Matlab Communication toolbox is also installed which is a software used for plotting various graphs and doing calculations also. It implements all the filters, source generators ,coding algorithms, modulation functions , scattering plot platforms, BER calculators, EyeDiagram plotter etc.It also supports coding algorithms for various filters design , modulation and demodulation, coders ,decoders etc. The proposed algorithm is being implemented here using the Communication Toolbox. Here we will show the simulation scenario, CCDF for the purposed scheme under various factors, the eye diagram for various OFDM signal with the purposed scheme. So at the end we will compare the conventional PTS scheme with the Purposed Scheme.

SIMULATION DETAILS AND SCENARIO:
The simulation details are taken for the OFDM signal with 256 no of subcarriers and the no of the sub-blocks in the proposed scheme are varied to change the PAPR of the signal . As we go on increasing the no .of sub-blocks [16,64,128] the value of PAPR goes on decreasing with the associated value of factor ‘r’ . we have consider the results onto CCDF platform .

V. SCENARIO PARAMETERS AND RESULTS

The same scenario parameters are applied to study both the traditional PTS scheme and the optimized scheme. The performance of both the schemes is compared in terms of PAPR by computing their CCDF plots. With the variation in the parameter ‘r’and the no of sub-blocks the best condition for PAPR of the OFDM signals has been evaluated. With the helf of CCDF plots,the PAPR of signal is plotted against the probability for minimum PAPR in a Two Dimensional graph. The CCDF plot compare PAPRo[dB] versus Pr[PAPR>PAPRo] with PAPRo[dB] on X-axis and Pr[PAPR>PAPRo] on Y-axis.
We are showing the comparison between conventional PTS scheme and the Optimized PTS for three different scenarios to better justify the results.
Results First Scenario
In the first scenario ,we are taking the OFDM signal with No. of Sub-blocks=16 with subcarriers N=256 ,and fig 5.4 is plotted with the value of ‘r=3, then we can see from figure that PAPR reduces from the conventional PTS scheme but from fig 5.5 we can see that there is a major change in the PAPR when r becomes equal to 4 so giving an efficient

PAPR value for r=4.

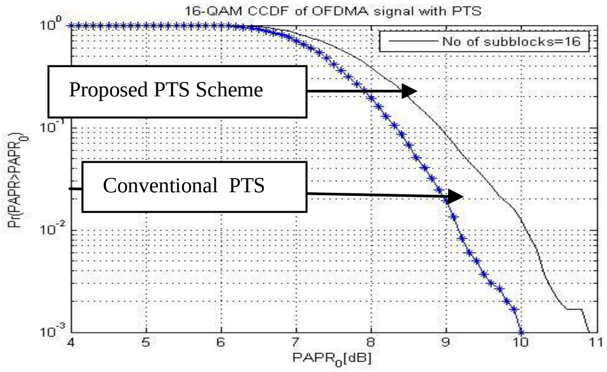


Fig CCDF for sub-blocks =16, with the value of r = 3.

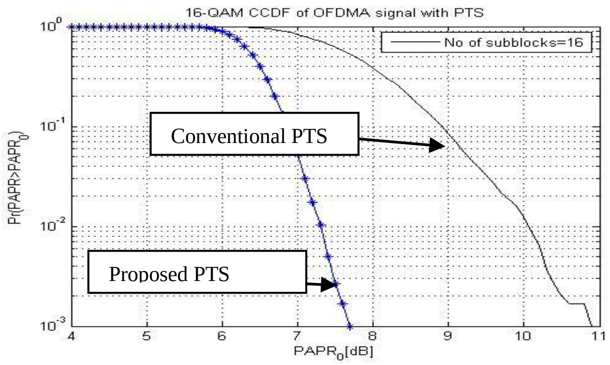


Fig CCDF for sub-blocks =16, with the value of r = 4.

Results Second Scenario:

In second scenario, we have consider the OFDM signal With 256 Subcarriers , and the no of sub-blocks has been increased in this case . So the value of r also has to be increased. We have Plotted the CCDF for the value of r=5 in fig which shows a change in the PAPR of the Optimized Scheme w.r.t conventional PTS scheme. This change goes on increasing as we further increase the value of r and this can be seen from fig where we get a better PAPR value. Although if we further increased the value of 'r' this will does not improve the PAPR so value of 'r' has to be confined to r=7.

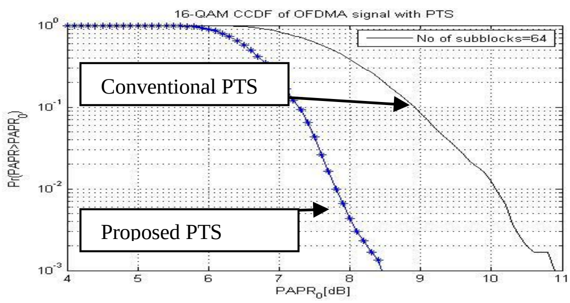
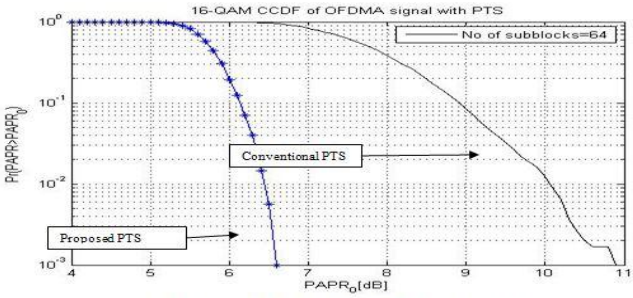
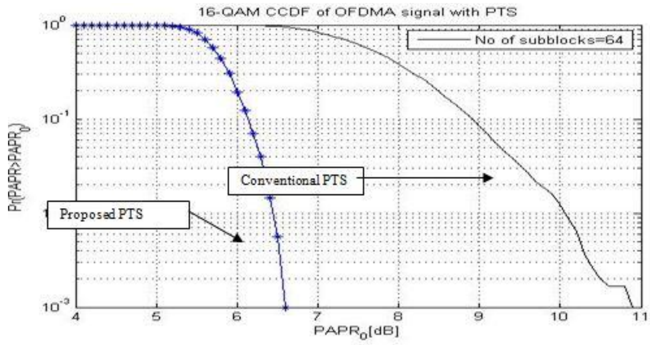


Fig CCDF for sub-blocks =64, with the value of r = 5.



CCDF for sub-blocks =64, with the value of r=6



VI. CONCLUSION

Since IEEE 802.16e standard is proposed to support mobility and it has become one of the most important QoS factors for comparison among various BWA schemes. In this dissertation, several fast HO schemes proposed by various researchers for IEEE 802.16e network are analyzed and a new handover scheme called the Optimized handover scheme is being proposed. This scheme takes weighted average of RSSI and idle capacity to choose the target BS while HO. This thus makes the MS to choose that BS as the target BS which has sufficient idle capacity to support the services of MS and can avoid packet loss. The Ping-Pong effect while HO is also minimized as the HO trigger is based on a probabilistic variable. With the help of simulations we have proven that the Optimized HO scheme is more efficient and tries to avoid congestion in the network. In other words this scheme reduces the waste of wireless resources and improves the performance of IEEE 802.16e broadband wireless networks.

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