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Performance Analysis of OFDM,UFMC and FBMC in Optical Wire Communication

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ABSTRACT
Optical Wireless Communications have become an essential research topic due to their potential spectrum efficiency. Nowadays, OWC evaluates many applications such as internet of things (IoT), visible light communication (VLC), and light fidelity (Li-Fi). OFDMA, FBMC, UFMC, recently used in 4G and 5G. This work is concentrated on providing a detailed study for the new modulation schemes. This article compared between BER, PAPR, spectral Density, and spectral efficiency of FBMC, UFMC, and OFDM modulation techniques to analyze the merits of them. The simulation results show that OFDMA has a higher BER, lower PAPR, compared to FBMC while FBMC has greater spectral efficiency and better performance of spectral density which makes it the optimum modulation schema among the rest. Furthermore, UFMC produces better results than OFDM and eliminates the complexity of FBMC.

1-INTRODUCTION

The Next Generation Mobile Networks (NGMN) Alliance highlights the necessity to make more spectrum available in the existing sub-6 GHz radio bands and introduce new agile waveforms that exploit the existing underutilized fragmented spectrum, in order to satisfy specific fifth-generation (5G) operating scenarios. The goal of the waveform symbiosis will be to flexibly optimize the use of existing underutilized spectrum resources, guarantee interference-free coexistence with legacy transmissions and provide an improved spectral containment compared to the orthogonal frequency division multiplexing (OFDM) modulation that is widely used in broadband wireless systems operating below 6 GHz. The massive number of devices and the support of multi-point transmissions in 5G use cases will imply the use of relaxed synchronization, potentially leading to strong inter-user interference.

OFDM is a multicarrier communication scheme that has been widely adopted in a number of different wired and wireless communication systems. Among others, 3GPP adopted it as the underlying physical layer (PHY) technology in mobile broadband systems denoted as 4G long- term evolution (LTE). It exhibits some intrinsic drawbacks including frequency leakage caused by its rectangular pulse shape, spectral efficiency loss due to the use of a cyclic prefix (CP) and need for fine time and frequency synchronization in order to preserve the carrier orthogonality, which guarantees a low level of intra and inter-cell interferences. To overcome these limitations, several alternative candidates have been intensively studied in the literature over the past few years, such as universal filtered multi carrier (UFMC) and filter bank multicarrier (FBMC).

The popular candidate 5G waveforms and compares them in terms of specific performance features such as spectral efficiency, peak-to-average power ratio (PAPR) and Bit Error Rate (BER) are presented in this work. Finally, presentation of practical implementations of FBMC-based waveforms demonstrating the feasibility of adopting such PHY layer schemes and verifying their superior performance when compared to CP-OFDM, under shared licensed spectrum use cases (i.e. a driving technology of several 5G use cases).

Depending on the end use and specific operation band (i.e. sub 6 GHz and millimeter wave frequencies), it is expected that two versions of 5G radio access waveforms will be standardized.

Details related to real-time implementation of 5G waveforms and laboratory-based experimental validation are very scarce in the literature and typically provide benchmarking of a particular use case. In conclusion, OFDMA, FBMC, and UFMC are important techniques in wireless communication systems, each with its strengths and weaknesses. Ongoing research and development aim to improve these techniques and push the boundaries of wireless communication. In optical communication:

2-LITERATURE SURVEY

Correlation of different generations of mobile from 1G towards 5G

Multi-carrier modulation (MCM) techniques are vital for achieving high data rates and robust performance in optical and wireless communication systems. With increasing demand for spectral efficiency and low-latency communication, Orthogonal Frequency Division Multiple Access (OFDMA), Universal Filtered Multi-Carrier (UFMC), and Filter Bank Multi-Carrier (FBMC) have emerged as key candidates for next-generation networks, including applications in optical wireless communication (OWC), radio-over-fiber (RoF), and fiber-optic broadband systems.

A road map of different mobile technologies is explained in Table 2.1. Challenges such as spectrum crisis and energy consumption which cannot be accommodated by 4G need to be resolved in 5G.

1st Generation (1G)	First generation of mobile (1980-190). It supported data rates from 1kbps to 2.8kbps. It used circuit switching, analog technology known as Analog Mobile Phone Service,40 MHz bandwidth and frequency range of 800- 900 MHz, frequency division multiplexing. It supported only audio. It provided low quality calls. Power consumption was very high. It suffered from various drawbacks such as poor audio links, low data capacity, no security & unreliable handoff.

2nd Generation (2G)	Second generation of mobile (1991-2007). 9.6kbps to 19.2kbps data rate with 64kbps maximum. It used packet switching to increase spectrum efficiency, digital technology A road map of different mobile technologies is explained in Table 2.1. Challenges such as spectrum crisis and energy consumption which cannot be accommodated by 4G need to be resolved in 5G.. The bandwidth required is about 20-200 KHz. It used GSM, IS-95 and CDMA technology. To improve the quality of audio, it used digital modulation. It provided email and SMS services. It is more secure using digital encryption to improve security, offered better connectivity. It cannot handle complex data like videos. Networks offered limited data services. It improved the transmission quality and coverage. 2.5G was launched between 2G and 3G. 200lbps data rate using Enhanced Data Rate and GPRS.
3rd Generation (3G)	Third generation of mobile (2008-2011). 144Kbps to 2Mbps data rate. The bandwidth is about 5-20MHz. It used circuit and packet switching, wireless web. Quality of voice and services improved. It supports CDMA, WCDMA, UMTS, HSUPA & HSDPA. Data rates are improved. It offered access to broadband multimedia services, wireless data, video calls. WLAN & Bluetooth allowed device to device communication. Quality of service was poor. It was unable to fulfill the demands of the network efficiently.
4th Generation (4G)	Fourth generation of mobile (2012-2019). 100 Mbps data rate in full mobility. 1Gbps data rate in low mobility. It uses CDMA multiplexing and packet switching, internet protocol. It offers support to integrated wireless solutions. It supports services & applications like High Definition Television, Digital Video Broadcast, Video Chatting and Multimedia Message Services. It offers global mobility support. LTE-A supports around 1Gb/s.

5th Generation (5G)	Fifth generation of mobile (2020 onwards). 10Gbps data rate. 6GHz frequency bands. Achieves 500+ Mbit/s speed. 5G networks are digital cellular. Sounds and images in analog form are converted to digital, transmitted in bits. 5G devices communicate using radio waves with low power transceivers and local antenna arrays over allocated frequency channels. Local antennas are connected to the internet via telephone network through optical fiber or wireless backhaul connection, thus offering high bandwidth. Massive MIMO is another technique which can be used for increasing the data rate. 5G supports million devices per sq km. It supports FCMA & BDMA. 5G works on device centric approach resulting in better throughput, reduced latency, improved system capacity and increased spectral efficiency.

Table 2.1: Different generations of mobile from 1G towards 5G

This survey explores existing research comparing these techniques in terms of key performance metrics such as Bit Error Rate (BER), Peak-to-Average Power Ratio (PAPR), spectral efficiency, and computational complexity, especially in the context of optical systems.

The literature suggests that while OFDMA continues to be a reliable baseline due to ease of implementation, UFMC provides a strong balance of performance and complexity, and FBMC offers the best performance for spectral efficiency and BER, especially for coherent optical and high-capacity networks. Future research is focusing on hybrid models and hardware implementations to mitigate FBMC's complexity in practical systems.

3-5G AIR INTERFACE DESIGN BASED ON UNIVERSAL FILTERED (UF)-OFDM

5G air interface design with respect to waveforms, multiple access and frame structure are discussed. 5G will be driven by supporting very heterogeneous service and device classes. A unified frame structure for handling those heterogeneous traffic types is presented. Multiple access for 5G will make use of strict synchronicity where it is justifiable and will drop it where signaling overhead and energy consumption will demand for. In order to serve this unified frame structure best, the choice of the underlying waveform is discussed. CP-OFDM has its limitations in spectral properties and in conjunction with relaxed time-frequency alignment. The most discussed contender so far is Filter-Bank based Multi-Carrier (FBMC), with better spectral properties but new drawbacks introduced by offset-QAM and long filter lengths. Hence, a new alternative is required: Universal-Filtered OFDM (UF-OFDM), also known as Universal Filtered Multi-Carrier (UFMC), is a recent technology close to OFDM. UF-OFDM, according to encouraging results so far, summarized in this paper, fits best to the 5G system requirements. A further feature of the Unified Frame Structure is the usage of multiple signal layers. Here, users can be separated e.g. based on their interleavers. This will introduce an additional degree of freedom for the system, improve robustness against crosstalk and help to exploit the capacity of the multiple access channel (MAC). Altogether, the proposed new concepts offer an emboldening approach for dealing with the new challenges, faced by 5G wireless system designers.

UF-OFDM is a filtered multi-carrier modulation technique derived from OFDM. Instead of applying a cyclic prefix to every symbol (as in OFDM), UF-OFDM filters a group of subcarriers (subbands) with short, well-designed filters. This improves spectral localization, reduces inter- subband interference, and enhances flexibility.

FBMC – Generalized Frequency Division Multiplexing

A generalized digital multi carrier transceiver concept where FBMC is based on traditional filter bank multi-branch multi-carrier concepts which are now implemented digitally. The FBMC approach exhibits some attractive features which are of particular importance for scenarios exhibiting high degrees of spectrum fragmentation. Spectrum fragmentation is a typical technical challenge of digital dividend use cases, exploiting spectrum white spaces in the TV UHF bands which are located in close proximity to allocated spectrum. Specifically, the FBMC features are a lower PAPR compared to OFDM, a ultra-low out-of-band radiation due adjustable Tx-filtering and last but not least a block-based transmission using cyclic prefix insertion and efficient FFT- based equalization. FBMC enables frequency and time domain multi-user scheduling comparable to OFDM and provides an efficient alternative for white space aggregation even in heavily fragmented spectrum regions. Filter Bank Multi-Carrier (FBMC) and Generalized Frequency Division Multiplexing (GFDM) are two advanced multicarrier modulation schemes proposed for 5G and beyond. While often discussed separately, they share conceptual similarities, especially in their efforts to improve on traditional OFDM by reducing spectral leakage, increasing spectral efficiency, and enhancing flexibility.

FBMC is sometimes considered as a special case or inspiration for GFDM due to its use of prototype filtering and time-frequency localization. Here, we explore FBMC and how its principles relate to and influence GFDM.

Performance Analysis of UFMC and its comparision with CP-OFDM

Cyclic Prefix Orthogonal Frequency Division Multiplexing (CP-OFDM) is used in 4G communication systems. There are problems in 4G Waveform such as out of band emission and lower spectral efficiency which forces to explore new waveforms for Fifth Generation (5G). Universal Filtered Multi-Carrier (UFMC) is one such air interface which is analyzed in this work and compared with CP-OFDM highlighting the merits of the candidate modulation scheme for 5G communication systems. This work presents the comparison UFMC and CP-OFDM on the basis of Peak to Average Power Ratio (PAPR) and Power Spectral Density (PSD) and analyze the performance of UFMC in Additive White Gaussian Noise (AWGN) channel using MATLAB. It is found that 40 dB reduction in out-of-band emission is seen in UFMC when compared to CP- OFDM with negligible increase in PAPR.

As 5G and future communication systems demand higher flexibility, better spectral containment, and robustness to channel imperfections, alternative multicarrier modulation schemes have gained attention. Universal Filtered Multi-Carrier (UFMC) is one such scheme that improves upon the widely used Cyclic Prefix-OFDM (CP-OFDM). This section explores the performance of UFMC and its comparison with CP-OFDM across critical metrics.

Universal Filtered Multi-Carrier (UFMC) is an advanced multicarrier modulation technique proposed for 5G and beyond, designed to address the limitations of traditional Cyclic Prefix- Orthogonal Frequency Division Multiplexing (CP-OFDM) used in 4G LTE systems. CP-OFDM is simple and widely used but suffers from high out-of-band emissions, limited spectral efficiency due to the cyclic prefix, and sensitivity to time and frequency synchronization errors. UFMC improves upon this by applying filtering to groups of subcarriers (subbands), which significantly reduces spectral leakage and enhances robustness in asynchronous and fragmented spectrum environments. Unlike CP-OFDM, UFMC does not require a cyclic prefix, thereby improving spectral efficiency. It also performs better in multipath and interference-prone channels, making it more suitable for 5G scenarios such as massive IoT and ultra-reliable low-latency communication (URLLC). However, UFMC introduces moderate computational complexity due to the filtering process. Overall, while CP-OFDM remains favorable for applications requiring low complexity and latency, UFMC offers superior performance in terms of spectral containment, bit error rate (BER), and flexibility—making it a strong candidate for modern wireless and optical communication systems.

4-PROPOSED SYSTEM – FBMC (PPN), UFMC

5G is the fifth generation wireless technology for digital cellular networks that began wide deployment in 2019. As with previous standards, the covered areas are divided into regions called "cells", serviced by individual antennas. Virtually every major telecommunication service provider in the developed world is deploying antennas or intends to deploy them soon. The frequency spectrum of 5G is divided into millimeter waves, mid-band and low-band. Low-band uses a similar frequency range as the predecessor,4G.

5G millimeter wave is the fastest, with actual speeds often being 1–2 Gbit/s down. Frequencies are above 24 GHz reaching up to 72 GHz which is above the extremely high frequency band's lower boundary. The reach is short, so more cells are required. Millimeter waves have difficulty traversing many walls and windows, so indoor coverage is limited. 5G mid-band is the most widely deployed, in over 20 networks. Speeds in a 100 MHz wideband are usually 100–400 Mbit/s down. In the lab and occasionally in the field, speeds can go over a gigabit per second. Frequencies deployed are from 2.4 GHz to 4.2 GHz. Sprint and China Mobile are using 2.5 GHz, while others are mostly between 3.3 and 4.2 GHz, a range which offers increased reach. Many areas can be covered simply by upgrading existing towers, which lowers the cost.

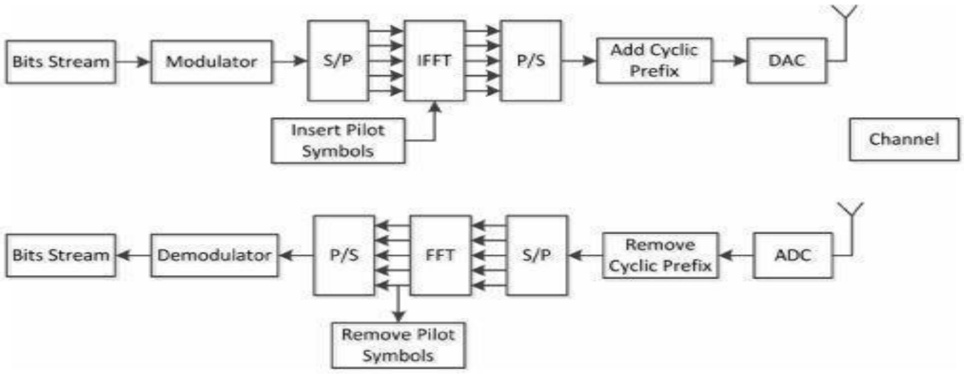
Performance – Speed

5G speeds will range from ~50Mbit/s to over 2 gigabit at the start, and is expected to grow to even 100Gbit/s, 100x faster than 4g. The fastest 5g, known as mmWave, delivers speeds of up to and over 2Gbit/s. As of July 3, 2019, mmWave had a top speed of 1.8Gbit/s on AT&T's. 5g network, much faster than 4g's top speed of 23.6Mbit/s on T-Mobile's network. The problem with this though is that it cannot go through walls, trees, etc. because of the high frequency. The similarity in terms of throughput between 4G and 5G in the existing bands is because 4G already approaches the Shannon limit on data communication rates. 5G speeds in the less common millimeter wave spectrum, with its much more abundant bandwidth and shorter range, and hence greater frequency reusability, can be substantially higher.

Basic Principle of OFDM

Future broadband wireless communication systems require high-speed data rate transmissions through severe multipath propagation channels. Orthogonal Frequency Division Multiplexing

(OFDM) is a multicarrier transmission technology for wireless digital communication systems because of its high-speed data rates, high spectral efficiency, high-quality service and robustness against narrow



band interference and Frequency Selective (FS) fading. OFDM is an efficient modulation that splits a single signal into various low data rate subcarriers. This scheme allows simultaneous transmission of data without interference from each other.

OFDM signals can easily adapt to severe channel conditions without complex time-domain equalization with high bandwidth efficiency. OFDM is an attractive technique for its robustness against narrow band channel interference, Inter Symbol Interference (ISI) and FS channels. However, the OFDM transmitted signal suffers from two major problems, i.e., high Peak to Average Power Ratio (PAPR) and Carrier 2 Frequency Offset (CFO). High PAPR is one of the most significant problems in OFDM, when the independent phases of subcarriers combine constructively. A High PAPR reduces the system efficiency and increases the system complexity. Several techniques, however, increase the Bit Error Rate (BER) while trying to decrease the PAPR.

OFDM System Model

The block diagram of the OFDM system is shown in Figure 4.1 . In this system, the input data stream is converted into N parallel data streams each with symbol period Ts through a serial to the parallel converter.

5-PAPR AND BER GENERAL CHARACTERISTICS

In this, Orthogonal Frequency Division Multiplexing (OFDM), Filter Bank Multicarrier (FBMC)and Universal Filtered Multi-Carrier (UFMC) are compared and PAPR of these techniques is analyzed by applying different subcarriers and modulation techniques. The spectral efficiency is poor in OFDM due to the presence of cyclic prefix and the efficiency can be improved by FBMC and UFMC. The use of separate filters for individual subcarriers eliminates the cyclic prefix and an increase in the sub carriers reduces the PAPR further. The PAPR varies according to the modulation techniques used.

PEAK TO AVERAGE POWER RATIO (PAPR):

The PAPR is the relation between the maximum power of a sample in a given OFDM transmit symbol divided by the average power of that OFDM symbol. In simple terms, PAPR is the ratio of peak power to the average power of a signal. It is expressed in the units of dB.

PAPR occurs when in a multicarrier system the different sub-carriers are out of phase with each other. At each instant they are different with respect to each other at different phase values. When all the points achieve the maximum value simultaneously; this will cause the output envelope to suddenly shoot up which causes a 'peak' in the output envelope.

Due to the presence of a large number of independently modulated subcarriers in an OFDM system, the peak value of the system can be very high as compared to the average of the whole system. This ratio of the peak to average power value is termed as Peak-to-Average Power Ratio. In the LTE system, OFDM signal PAPR is approx.12dB.

Crest factor is a parameter of a waveform, such as alternating current or sound, showing the ratio of peak values to the effective value. In other words, the crest factor indicates how extreme the peaks are in a waveform. Crest factor 1 indicates no peaks, such as direct current or a square wave. Higher crest factors indicate peaks, for example sound waves tend to have high crest factors.

Crest factor is the peak amplitude of the waveform divided by the RMS value of the waveform. This is equivalent to the ratio of the L_∞ norm to the L_2 norm of the function of the waveform.

The peak-to-average power ratio (PAPR) is the peak amplitude squared (giving the peak power) divided by the RMS value squared (giving the average power).

The comparison of complementary cumulative distribution function (CCDF) of the PAPR of selected 5G candidate waveforms

BIT ERROR RATE (BER):

In digital transmission, the number of bit errors is the number of received bits of a data stream over a communication channel that have been altered due to noise, interference, distortion or bit synchronization errors. The bit error rate (BER) is the number of bit errors per unit time. The bit error ratio (also BER) is the number of bit errors divided by the total number of transferred bits during a studied time interval. Bit error ratio is a unitless performance measure, often expressed as a percentage.

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
- Data acquisition
- 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. Today, MATLAB engines incorporate the LAPACK and BLAS libraries, embedding 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 add-on application-specific solutions called toolboxes. Very important to most uses 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.

DEVELOPMENT ENVIRONMENT

This provides a brief introduction to starting and quitting MATLAB, and the tools and functions that help you to work with MATLAB variables and files. For more information about the topics covered here, see the corresponding topics under Development Environment in the MATLAB documentation, which is available online as well as in print.

Starting and Quitting MATLAB Starting MATLAB

On a Microsoft Windows platform, to start MATLAB, double-click the MATLAB shortcut icon on your Windows desktop.

On a UNIX platform, to start MATLAB, type matlab at the operating system prompt. After starting MATLAB, the MATLAB desktop opens - see MATLAB Desktop.

You can change the directory in which MATLAB starts, define startup options including running a script upon startup, and reduce startup time in some situations.

Quitting MATLAB

To end your MATLAB session, select Exit MATLAB from the File menu in the desktop, or type quit in the Command Window. To execute specified functions each time MATLAB quits, such as saving the workspace, you can create and run a finish .m script.

MATLAB Desktop

When you start MATLAB, the MATLAB desktop appears, containing tools (graphical user interfaces) for managing files, variables, and applications associated with MATLAB.

The first time MATLAB starts, the desktop appears as shown in the following illustration, although your Launch Pad may contain different entries.

You can change the way your desktop looks by opening, closing, moving, and resizing the tools in it. You can also move tools outside of the desktop or return them back inside the desktop (docking). All the desktop tools provide common features such as context menus and keyboard shortcuts.

You can specify certain characteristics for the desktop tools by selecting Preferences from the File menu. For example, you can specify the font characteristics for Command Window text. For more information, click the Help button in the Preferences dialog box.

8-RESULTS

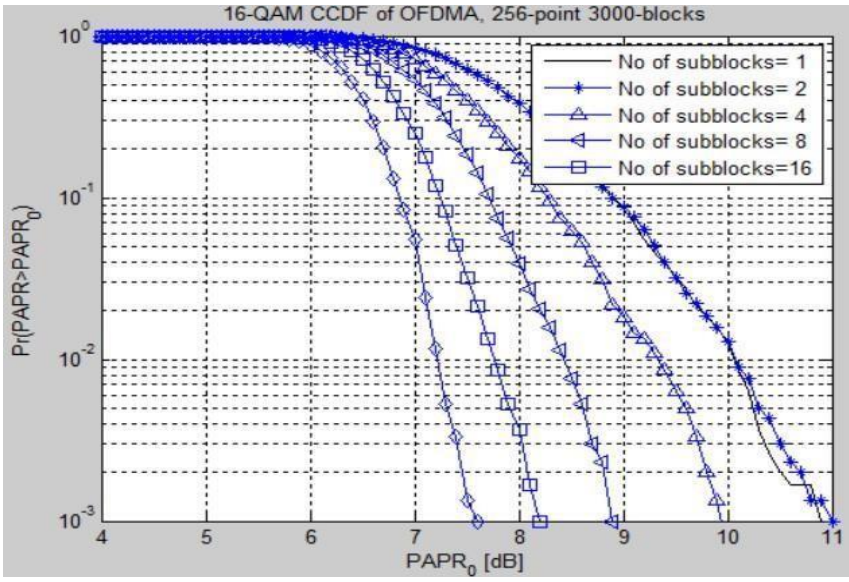
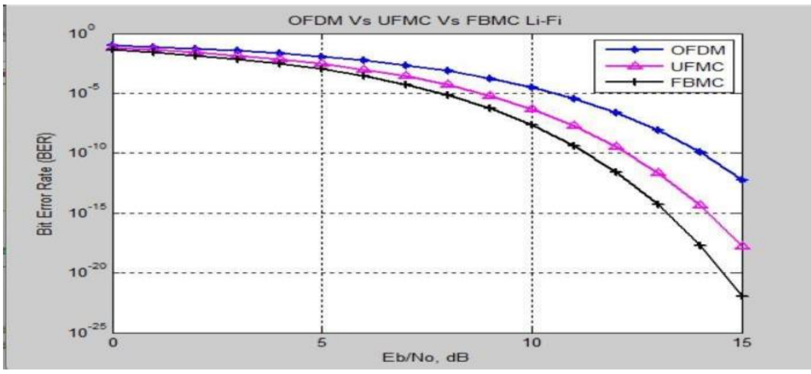


Fig 1: PAPR[dB] vs Pr(PAPR>PAPR)(Graph 1)

Observations:

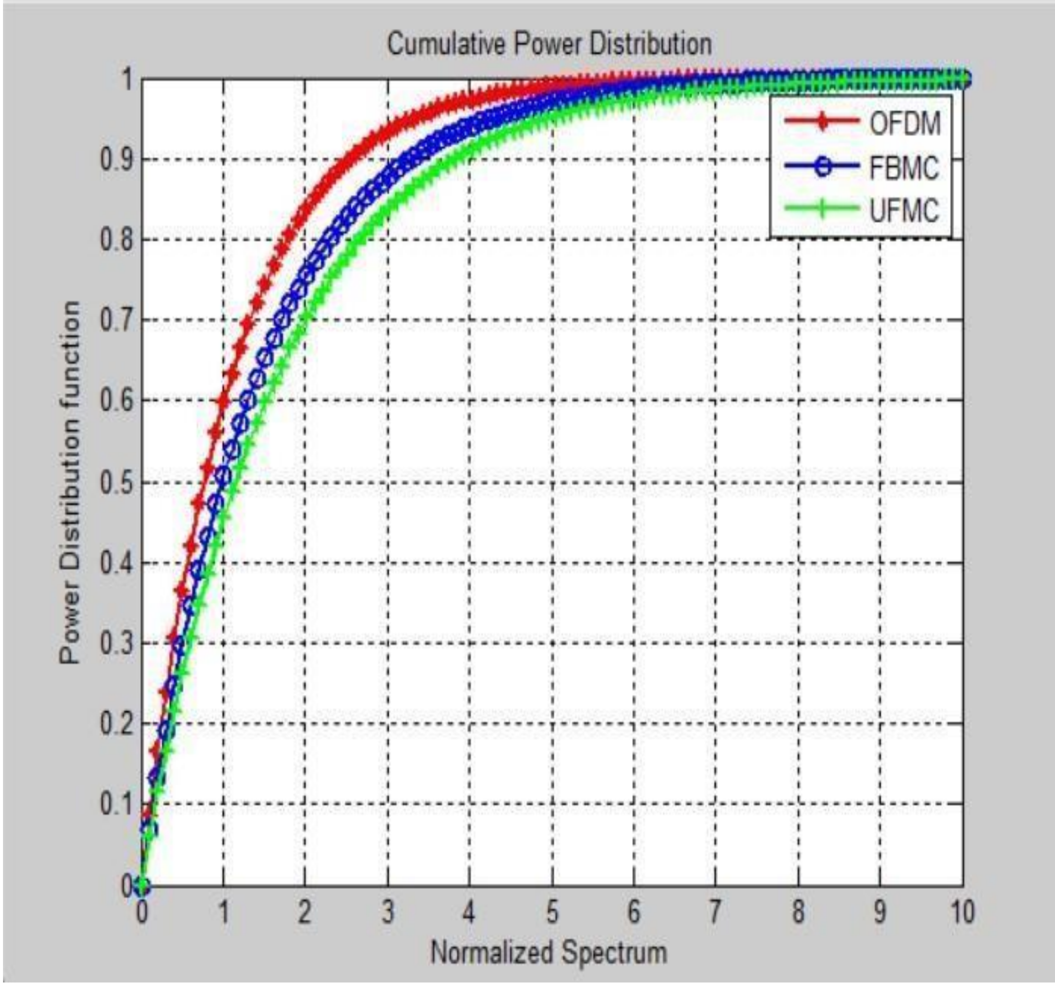


- The graph shows that as the number of subblocks increases, the PAPR decreases.
- The curve for 1 subblock has the highest PAPR, while the curve for 16 subblocks has the lowest PAPR.
- The graph indicates that increasing the number of subblocks can help reduce the PAPR in an OFDMA system.
- The PAPR is an important metric in wireless communication systems, as high PAPR values can lead to distortion and reduced system performance.
- The graph suggests that OFDMA systems with a larger number of subblocks may have better PAPR performance, which can be beneficial in optical wireless communication systems.

Conclusion:The graph provides valuable insights into the PAPR performance of OFDMA systems with different numbers of subblocks. The results can be used to inform the design and optimization of OFDMA systems for optical wireless communication applications. However, to fully address the performance analysis of OFDMA, UFMC, and FBMC, additional graphs or data would be required to compare the performance of these different modulation schemes

.Fig 8.2: Bit Error Rate (BER) vs. Eb/No (Graph 2) Bit Error Rate (Graph 2):

Observation :



FBMC (black line) shows the lowest BER across all Eb/No values.

UFMC (magenta line) performs better than OFDM but not as good as FBMC. OFDM (blue line) has the highest BER at all Eb/No levels.

Conclusion :

FBMC exhibits superior noise immunity and better spectral containment, making it more reliable under noisy channels, ideal for 5G/Li-Fi environments.

Cumulative Power Distribution (Graph 3):

Observation :

OFDM has the steepest curve, meaning it concentrates more power in fewer subcarriers. FBMC and UFMC distribute power more gradually, showing better power spectral shaping. Conclusion: FBMC and UFMC offer better spectral efficiency and lower out-of-band emissions, reducing interference in adjacent channels, which is critical in fragmented spectrum use cases.

Fig 8.3: Normalized Spectrum vs Power Distribution Function CDF of Error Probability vs. SNR (Graph 4):

Observation :

FBMC shows the lowest error probability for a given SNR. UFMC again is intermediate.

OFDM has the highest error probability, especially at low-to-mid SNR levels.**Conclusion:**

FBMC is more robust against errors, validating its design for asynchronous multi-user 5G uplink scenarios.

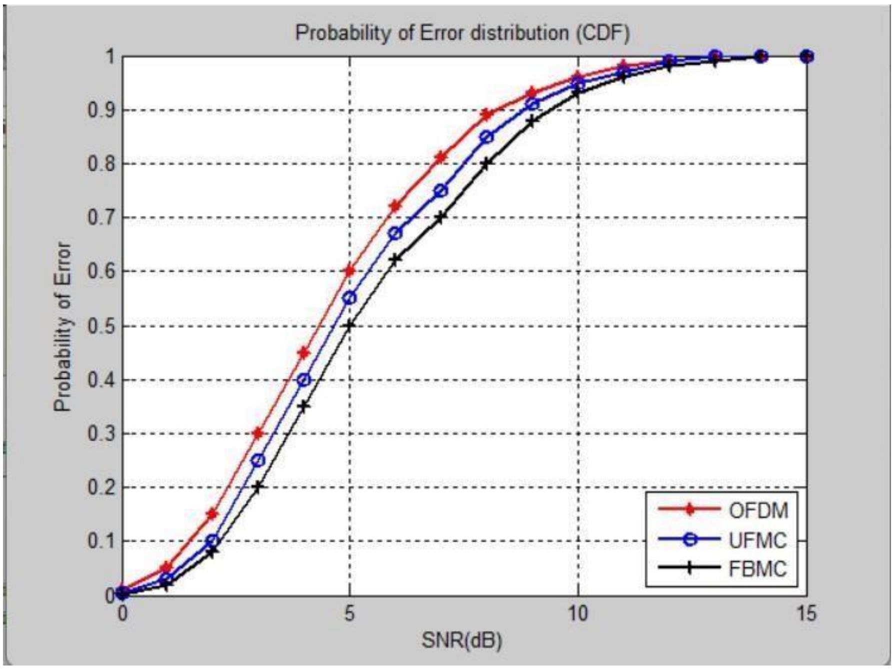


Fig 4: CDF of Error Probability vs. SNR (Graph 4) BER vs. SNR (Simulated vs. Theoretical - Graph 5)

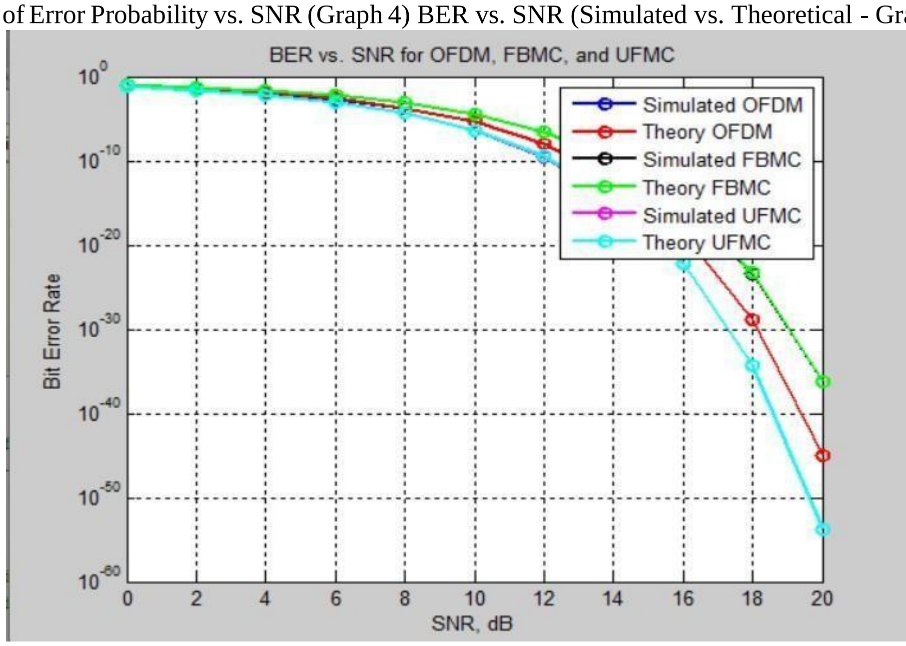


Fig.5: BER vs. SNR (Simulated vs. Theoretical - Graph 5)

Observation :

All systems follow their theoretical trends closely.

UFMC theoretical (cyan) shows the steepest BER drop, indicating its potential in ideal conditions.

Simulated FBMC (black) maintains good performance, verifying practical applicability.

Conclusion :

FBMC and UFMC both offer practical advantages over OFDM. UFMC maintains better performance in ideal simulation, while FBMC shows consistency in real-world modeling.

Final Result:

Metric	OFDM	UFMC	FBMC
BER Performance	Poor	Moderate	Best
Spectral Efficiency	Low (due to CP)	Moderate (filtered subbands)	High (filter banks, no CP)
Out-of-Band Emission	High	Moderate	Very Low
PAPR	High	Moderate	Low
Implementation Complexity	Low	Moderate	High

Table 8.1: performance od OFDM,UFMC and FBMC

9-CONCLUSION

In this work, a fair comparison of several 5G multi carrier waveform candidates (OFDM, UFMC, FBMC) has been conducted under a common framework. PAPR and BER have been assessed for the different waveforms. Resistance of the waveforms in a typical asynchronous multi-user uplink scenario, for different parameterization and configuration, has also been addressed. UFMC preserves backward compatibility with well-known OFDM algorithms (channel estimation, MIMO detectors). FBMC-OQAM go a step further: interference between adjacent bands is minor, making these waveforms particularly interesting for 5G scenarios, at a price of slight complexity increase. FBMC-OQAM is a promising solution even when it comes to practical implementations: in this , presentation of results that reveal the feasibility of the FBMC-OQAM waveform are done. Demonstration of the relevance of FBMC especially when targeting the deployment of secondary systems in existing underutilized (and spectrally fragmented) bands, where interference protection of primary transmissions is mandatory is performed. Two different DL FBMC systems were implemented and validated when coexisting at the same band either with primary PMR or TVWS transmissions. The efficient and non-interfering shared utilization of licensed spectrum (either between primary or primary and secondary transmissions) is an enabler of 5G systems the benefits of which can also be applied on unlicensed shared spectrum access (or even combinations of the two)

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