5th Generation of Gfdm and Analysis of Ser Using Filter

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Abstract
GFDM (Generalized Frequency Division Multiplexing) is fifth generation wireless communication network and 5G based on multi branch multicarrier bank. GFDM is a non-orthogonal and circular pulse shaped waveform using channel condition for performance analysis. This paper presents a review of different method for generalized frequency division multiplexing to calculate various parameter in based on 5th generation of wireless communication system space diversity and different error correcting code, determine the various parameter and different bandwidth. pulse shaping filter used in GFDM based wireless system, have an impact on the performance of system in presence of inter symbol interference
Keywords: Generalized frequency division multiplexing (GFDM), Inter symbol interference (ISI), Inter carrier interference (ICI), Multicarrier (MC), Carrier frequency offset (CFO), Out of band (OOB) and Orthogonal frequency division multiplexing (OFDM)

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Biographical notes Megha Gupta received a graduation degree in Electronics and Communication Engineering and degree in digital communication. Currently she is working as a PhD candidate under the guidance of Dr. R.S. Gamad, professor and Head Electronics & instrumentation Engineering department in Shri G.S. Institute of Technology and Science, Indore, India. Her research area include wireless, signal processing, OFDM, MIMO, 5G, Next generation in wireless network etc

Dr. R. S. Gamad has more than 24 years of teaching and research experience. He has started his carrier in 1996. Currently he is professor and head Department of Electronics & Instrumentation Engineering, Shri G. S. Institute of Technology & Science, Indore (M.P) and leading "Analog and mixed signal circuit design and testing, VLSI Circuit and System Design" at Discipline of Electronics & Instrumentation Engineering. He obtain his PhD degree from Department of Electronics & Instrumentation Engineering, SGSITS, Indore, RGPV Technical University , Bhopal (M.P.) India in 2010. As of now 02 PhD students has been awarded their PhD degree and Four had been submitted to RGPV Bhopal for awarding Ph.D. and at present four PhD scholars are registered apart from several M.Tech and B.Tech Students. He has completed two research projects and one is ongoing funded by MHRD, MeitY, Govt. of India. His has published 66 research papers in SCI, Scopus indexed International & National Journals and International & national Conferences. He is member of IETE, IE India and reviewers of several reputed Journals. He was the Coordinator of VDAT 2019 conference and has been associated with several reputed conferences across the globe as a member of technical program committee.

I. Introduction

Wireless Communication is transfer of information from one point to other, without using any association like wires, cables or any physical medium. Beginning from the first generation (1G), which provide voice transmission. Then, the second generation (2G) digitalized the voice working the Quality of Service and incorporating the Short Message Service. With the presence of smart phones with high quality cameras and screens, large storage and processing capabilities appeared the third generation(3G) emerged, enabling mobile Internet access with acceptable data rates. The 3G scenario, joined with the increasing use of the social networks mobile communications evolution in focusing on increasing the throughput as it was done with the fourth generation(4G). machine type communication (MTC) or gen- erally, Internet of Things (IoT), Tactile Intenet, bitpipe connectivity and wireless Regional Area Netwok (WRAN), the fifth generation (5G), should provide different requirements beyond increasing the throughput[1]. Internet of thing (IoT), low latency for Tactile Internet and high inclusion and dynamic range part with low out-of-band (OOB) emission to cover Wireless Regional Area Network applications. Despite its robustness against multipath channels and easy implementation its accepted that it cannot stand the emergent quality of service requirements, due to its low spectral efficiency. Consequently, filter bank multicarrier ((FBMC)) is considered as a candidate waveform for the fifth generation, which is characterized for its low OOB radiation, provided for the individual pulse shaping. However, the long response of the transmit filter is not compatible with the use for low latency applications, which require a high spectral efficiency that is only achieved with short burst transmissions. FBMC high spectral efficiency is only achieved if the number of transmit symbols is large enough[2]. Therefore, the fact that a single flexible waveform can be applied to the all differ-ent 5G scenarios, instead of one specific waveform for each 5G scenario, is interesting. This candidate is GFDM, a waveform that employs the innovative concept of a cir-cular filtered multicarrier (MC) system, that is based on the modulation of independent blocks and provides a highly flexible time-frequency structure[3].

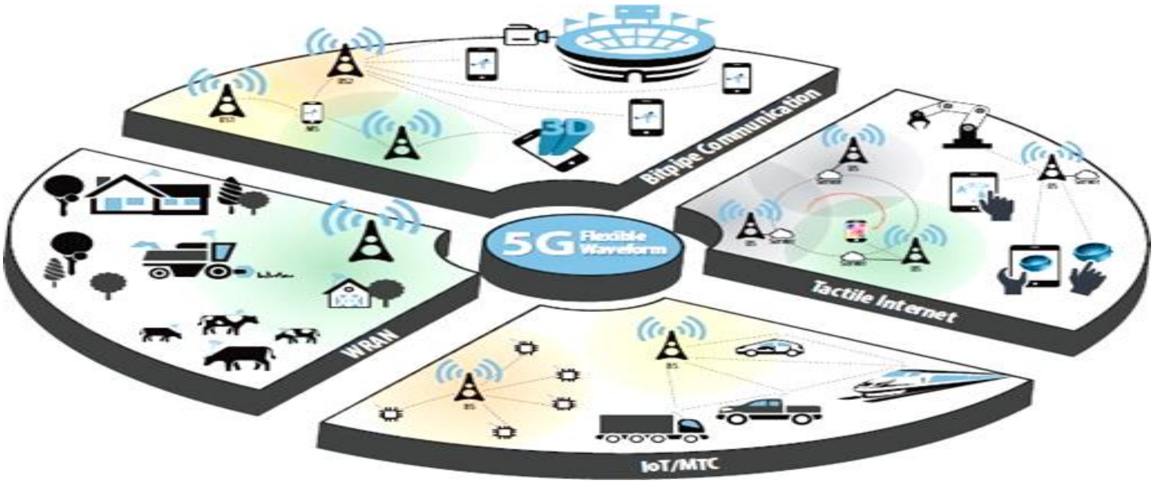

Figure 1: 5G application

The figure 1 shows 5G is the fifth generation of wireless communication system. 5G is going to change everything, every industry, every business, and every consumer experience. It will power massive broadband applications and it will create unprecedented opportunities. The next generation telecom networks (5G) will hit the market by 2020. Beyond just speed improvements, 5G is expected to unleash a massive IOT ecosystem where networks can serve communication needs for billions of connected devices, with the right trade-offs between speed, latency and cost. The new technologies are being investigated that provide high speed, capacity, spectral efficiency, energy efficiency, pseudo outdoor communication.

Generalized Frequency division multiplexing based on 5G technology application

1. Machine type communication

2. Internet of thing

3. High data rate mobile communication

Generalized frequency division multiplexing (GFDM) is a novel idea that can be seen as a generalization of conventional orthogonal frequency division multiplexing (OFDM). GFDM is non orthogonal frequency division multiplexing. it show that based on the fast Fourier transform/inverse fast Fourier transform (FFT/IFFT) calculation, the plan can be executed with sensible computational effort[4]. Further, to have the option to relate the outcomes to the new long term evolution (LTE) standard, we present a reasonable arrangement of boundaries for GFDM. GFDM depends on 5G innovation[5] .This technology has faster response time, very high capacity, wide range of application, speed up to 10 GB/s, and more software option to Upgrade etc. Generalized frequency division multiplexing (GFDM) is non orthogonal multicarrier waveform . Multicarrier (MC) modulation is a technique that divides a robust performance in frequency selective channels[6,7]. With future application expectations in mind, there is an ongoing intense search for new multicarrier waveforms, with high spectral efficiency, high data rates, high Quality of Service (QoS), low latency and low out-of-band (OOB) emissions.5G has different requirements due to the verity of its application like machine type communication, internet of things, high data rate mobile communication[8,9].

OFDM system has several drawbacks such as large out of band radiation. high baud rate signal into multiple lower baud rate subcarriers. It has attracted a lot of attention due to its robust performance in frequency selective channels[10]. With future application expectations in mind, there is an ongoing intense search for new multicarrier waveforms[11,12], with high spectral efficiency, high data rates, high Quality of Service (QoS), low latency and low out-of-band (OOB) emissions.5G has different requirements due to the verity of its application like machine type communication, internet of things, high data rate mobile communication. OFDM system has several drawbacks such as large out of band radiation. The figure 2 indicate Multicarrier modulation, MCM is a technique for transmitting data by sending the data over multiple carriers which are normally close spaced. Multicarrier modulation has several advantages including resilience to interference, resilience to narrow band fading and multipath effects. As a result, multicarrier modulation techniques are widely used for data transmission as it is able to provide an effective signal waveform which is spectrally efficient and resilient to the real world environment [13].

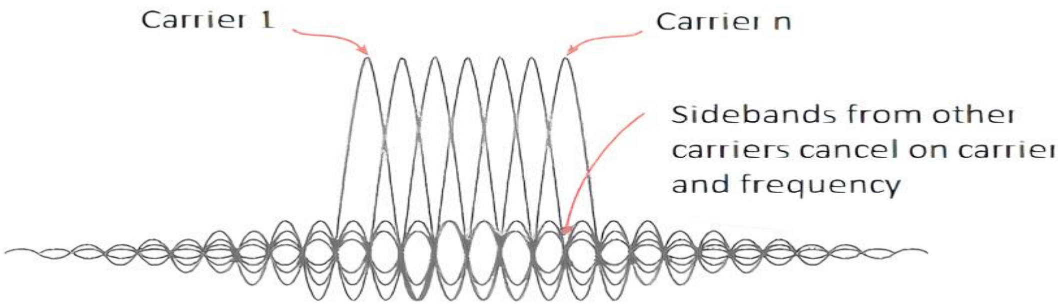

Figure 2: Multicarrier waveform

Multicarrier modulation operates by dividing the data stream to be transmitted into a number of lower data rate data streams. Each of the lower data rate streams is then used to modulate an individual carrier. .When the overall transmission is received, the receiver has to then re-assemble the overall data stream from those received on the individual carriers.

It is possible to use a variety of different techniques for multicarrier transmissions. Each form of MCM has its own advantages and can be sued in different applications. OFDM is possibly the most widely used form of multicarrier modulation. It uses multiple closely spaced carriers and as a result of their orthogonality, mutual interference between them is avoided. Generalized Frequency Division Multiplexing (GFDM) is a multicarrier modulation scheme that uses closed spaced non-orthogonal carriers and provides flexible pulse shaping. It is therefore attractive for various applications such as machine to machine communications. GFDM system performs better in terms of out of band radiation. Symbol error rate (SER) performance of generalized frequency division multiplexing and OFDM can be the same. To achieve this requirement different technique will be deployed Massive multiple input multiple outputs, millimeter waveband, new physical layers waveform. The main focus of this work is on physical layer waveform is a key factor due to its impact on transceiver complexity and system level performance 5G waveform selection are divided to enhance and alternative OFDM waveform, using a new waveform such as Filter bank multicarrier

(FBMC), Universal filtered multicarrier (UFMC), Bi orthogonal frequency division multiplexing (BFDMB), Generalized frequency division multiplexing(GFDM) The figure 3 shows Generalized frequency division multiplexing all data frame are connected one by one and cyclic prefix added start and end of frame and orthogonal frequency division multiplexing each data frame are connected before and after cyclic prefix.

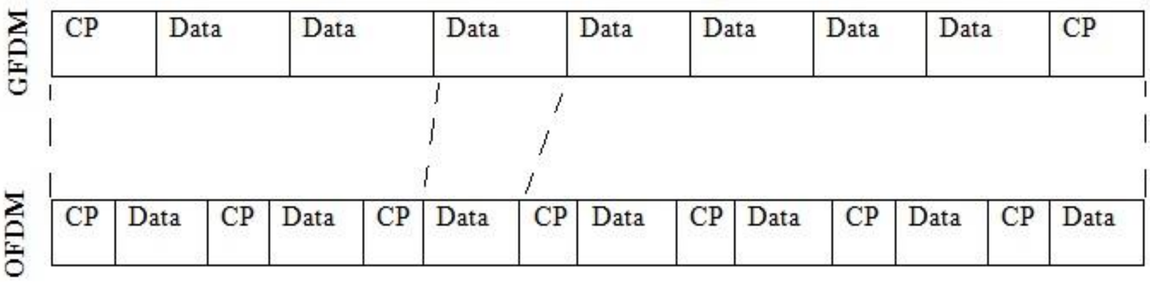

Figure 3: GFDM and OFDM Frame

The figure 4 represent in GFDM, the data symbols are transmitted in the form of blocks. Each data block contains K sub-carriers and each sub-carrier is further divided into M sub-symbols. The sub-carriers used are not orthogonal to each other. The pulse shaping of sub-carriers are performed using filter shifted in both domains time and frequency. OOB emissions get reduced by this process. There is only single CP used for a GFDM block which increases ICI and ISI.

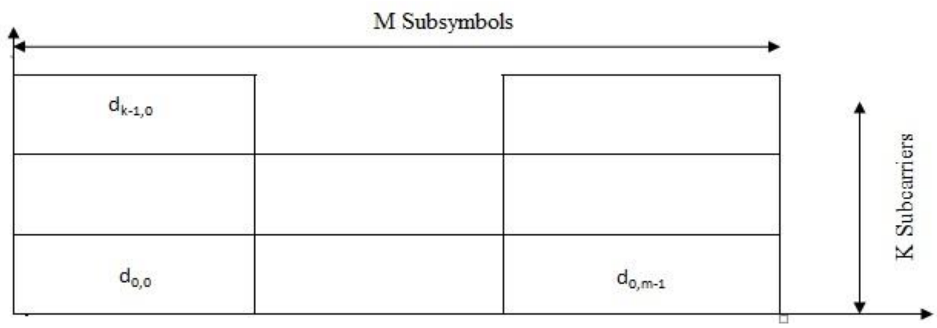

Figure 4: Division of sub-carriers and sub-symbols in GFDM.

GFDM is digitally applying classical filter bank which is used non orthogonal, digital multicarrier transmission. It enables time and frequency domain multiuser comparable to OFDM scheduling and in cellular systems such as opportunistic spectrum utilization and machine-to-machine communication, with a focus on asynchronous low duty cycle transmission and non-continuous bandwidths. GFDM transreceiver encoded symbols belong to line of complicated constellation factors in which denotes the amount of bits in keeping with symbol, additionally referred to order of modulation. GFDM trasreceiver is given in figure1 This is K= MN manufactured from two integers[3]. The k factors are frequently visualized as disintegrated into N subcarrier with the GFDM system overlapping factor. The NM X I columns vector d=[d(0)…………d(M-1) denotes the transmitted data on the subcarrier. The baseband send signal in digital communication is accomplished through the sum of all subcarrier and sub symbol signals according to [4,5].

$$x[n] = \sum_{k=0}^{K-1} \sum_{m=0}^{M-1} gk,m[n]dk,m\,, \qquad n = 0, \ldots, N-1 \qquad (1)$$

Collecting the filter samples in a vector allows formulating as

$$\vec{x} = A\vec{d} \qquad (2)$$

Where A is KM*KM is a transmitter matrix

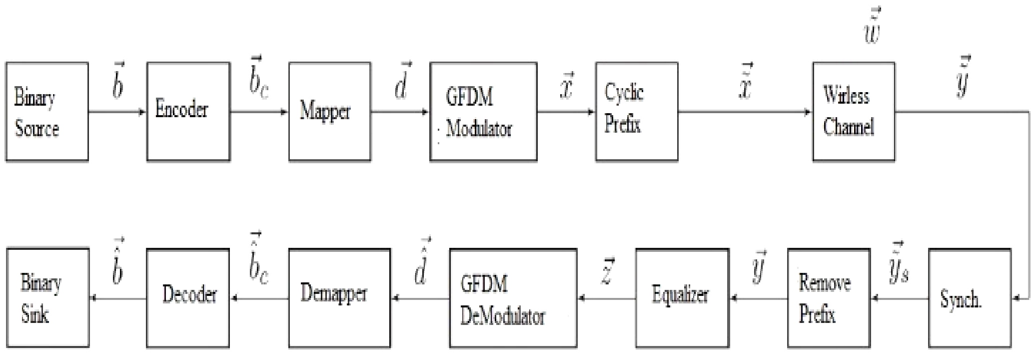

Figure 5: GFDM transceiver

The figure 5 indicate GFDM transmitter is various operation performed binary source generates the data in the binary form (i.e. '1' and '0'). This binary data is represented by vector b and give as an input to the encoder. binary data is given as an input to the encoder which splits the higher bit rate stream into lower bit rate streams. The encoded output, be is then given as an input to the mapper. The figure 6 shows In the GFDM modulator, various operations are performed on the data vector,d which are explained in the subsequent sections. After that serial-to-parallel converter, the mapped data is decomposed into K sub-carriers having M sub symbols each as given, $\boldsymbol{d}$ = [$d0$ $d1$……………..dK−1]and $\boldsymbol{dk,m}$ = [dk,0 dk,1……………..dk,M−1] T . The dk,m is the data transmitted on the kth sub-carrier and in the mth sub-symbol of the block and N=KM is the total symbols present in a GFDM block[1,3].

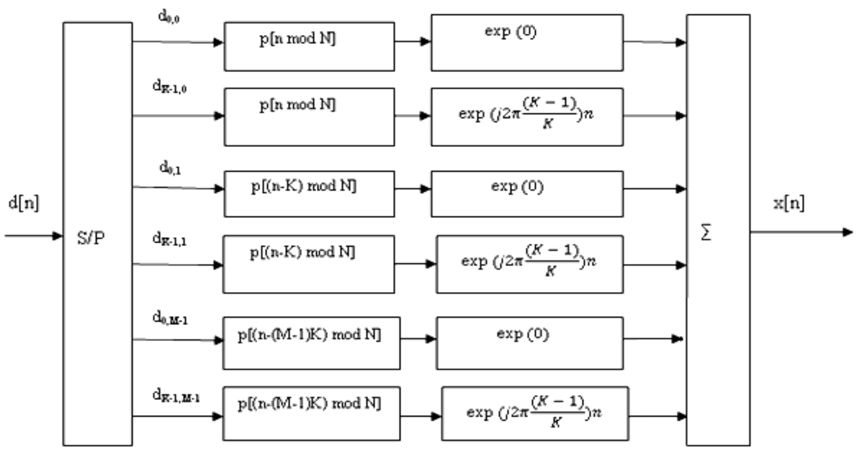

Figure 6: GFDM modulator

Serial-to-parallel conversion, pulse shaping operation is performed on each data symbol separately as represented by the equation

$P_{k,m[n]} = p[(n - mK) mod N]\ e^{j2\pi nk/K}$ where n is the sampling index, $p[n]$ is the pulse shaping used and $P_{k,m[n]}$ is the pulse shaping filter, p[n] after shifting in both time and frequency domain. In this shifted version of pulse shaping filter, complex exponential performs shifting in frequency domain and modulo operation performs shifting in time domain.

The transmit samples(x) are attained by superpositioning the transmitted symbols

$x[n] = \sum \sum pk,[n]dk,m,\ n = 0,1, \ldots \ldots N - 1$ (4)

or by collecting the pulse shaping samples in a vector

$pk,m = (pk,m[0], pk,m[1], \ldots \ldots \ldots, pk,m[N])\ T$ (5)

we can rewrite the equation(5) in matrix notation as

$x=Bd$ (6)

where B is a $KM \times KM$ transmitter modulation matrix as given by the equation

$B = [p0,0 \ldots \ldots .pK-1,0, p0,1 \ldots \ldots \ldots .pK-1,M-1]$

After modulation of the transmitted signal, cyclic prefix is added at the end of the GFDM block. The length of the CP is equal to K/4 that is, one-fourth of the number of sub-carriers used. The transmitted

signal after the addition of the CP is given by the equation

$x_{cp}=[(N-Ncp: N-1)^T x^T]$ (7)

The above signal is then transmitted through the wireless channel .The transmitted signal is transmitted over a wireless channel. The signal is transmitted through channel having AWGN noise and Rayleigh fading channel.

The transmitted signal is then reached at the receiver side after passing through the wireless channel. The received signal is given as

$y = Hx_{cp} + w$ (8)

From the received signal, CP is removed first. The signal after the removal of CP is given by the equation

$y = y(N_{cp}: N_{cp} + N - 1)$ (9)

When a signal transmitted through channel, it gets distorted due to ISI. The equalizer is used to get the desired signal back by removing the distortion caused due to channel. It preserves both frequency component and actual shape of the signal. In this GFDM model, zero forcing equalization is performed. The received signal after equalization is given by

$z=H-1Hx+H-1w=x+w$ (10)

After equalization, linear demodulation is performed. The receiver used for this type of demodulation is of three types Zero Forcing (ZF) receiver, Matched Filter (MF) receiver, Minimum mean square error (MMSE) receiver. QAM De-mapper the demodulated output, is given as an input to the QAM de-mapper which reverse the process of QAM mapper. It converts the received data symbols into data bits. The decoded output is then taken as the final received data which is same as the input data if there are no errors occur in the process.

This figure 7 shows different type of multiplexing OFDM is orthogonal frequency division multiplexing divided carrier into subcarrier and transmitted over the channel. Single carrier frequency division multiplexing divided N sub symbols into sample. GFDM is generalized frequency division multiplexing is block based structure divided into symbol into sub symbol and carrier into subcarrier

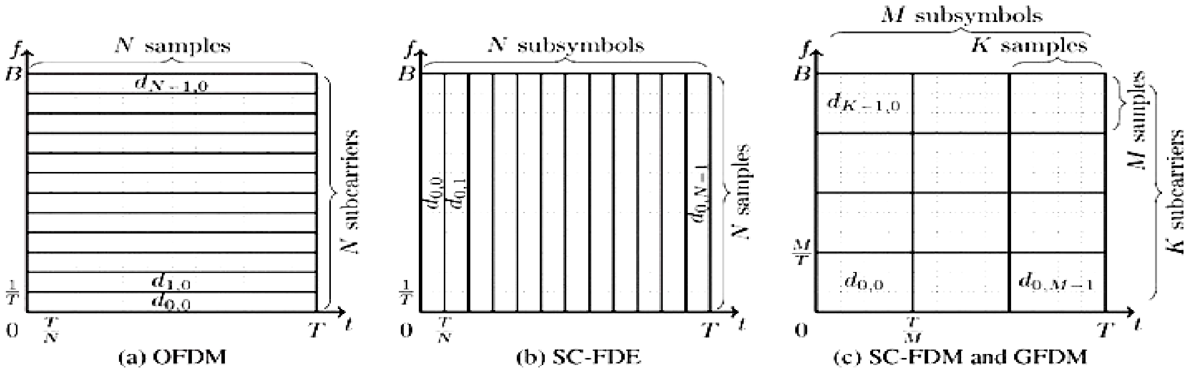

Figure 7: Partiting of time and frequency (a) K=N subcarrier and M=1 subsymbol (b) k=1 subcarrier and m=n subsymbol (c) k=4, M=3 ,N=12

II. COMPARATIVE ANALYSIS OF GFDM TECHNOLOGY USING VARIOUS METHOD

Survey exhibits that several methods are known GFDM using many challenges carrier frequency offset, timing offset channel estimation work at different technique like that pulse shaping filter, Self interference cancellation, matched filter, synchronization of this multicarrier technique, Walsh handmard transform (WHT) also can be used determine to various parameter bit error rate symbol Error rate. This later approach gives more accurate results, Earlier reported different standards method suffers from various limitation that give low latency, timing error, frequency misalignment, time and system latency, noisy environment. This limitation can be resolved by various techniques. Walsh handmard transform technique (WHT) with GFDM to improve the performance against frequency selective channel and WHT is suitable for low-latency situations predicted for 5G,Frequency selective offset quadrature amplitude modulation provide low implementation complexity [14-17]. Synchronization technique for generalized frequency division multiplexing reduce sideslobes of the spectrum emission.Pulse shaping Technique and synchronization errors[18-20] are the presence of predict the GFDM bit error rate performance .GFDM is evaluate the symbol error rate in 16 quadrature amplitude modulation . Receiver filter was proposed to work at carrier frequency offset, Timing offset , OFDM and GFDM waveforms. In cognitive radio network channel estimation is the reliable spectrum sensing. Bit error rate and Symbol error rate also calculated and weighted type fractional Fourier transform was proposed to work at Carrier frequency offset and timing offset. Bit Error rate also calculated. Adaptive cancellation filter and Weighted parallel interference cancellation was proposed Carrier frequency offset and timing offset, Rayleigh quotient problem. SIR (Signal to interference ratio) analyses are calculated [21-24]. Pseudo noise (PN) propose an approach for signal synchronization.Alamouti and MIMO scheme were presented with IQ imbalance, signal to interference imbalance and normalized complex least mean square for GFDM receiver. Self interference cancellation was proposed to work at radio frequency impairment and study uplink and downlink user. Matched filter technique were discussed at the receiver result that cancel the effect of interference due to non orthogonality of GFDM waveform in radar processing. Dual Filter work on channel estimation and multi input and multi output system bit error rate is calculated [25-30]. Author has reported comparison of different methods for determination of ISI and ICI calculate the parameter of bit error rate, symbol error rate over simulated different test condition. In this paper a novel technique has been discussed for a valuable research result. Table 1 contain important contribution reported in literature for determination of various parameter of Generalized Frequency division multiplexing based on 5G technology[31-34]. GFDM provides the higher spectral efficiency, which allows reducing the frequency band occupied by the signal and improving the electromagnetic compatibility of many terminals. GFDM have many application like Machine-Type Communications (MTC),IOT, Cognitive Radio (CR) [35]. Here concluded that GFDM is most important technique for the 5G analysis and performance important .

Table 1: Comparative analysis of various parameter of GFDM using 5G.

Name of technique	Name of author with reference number	Year of publication	Reported work	Computed parameter	Limitation
Walsh handmard transform (WHT)	Nichola Mchailow [14]	2014	Robust against frequency selective channel to improve the system with help of WHT	BER	Flat channel is not likely to improve performance.
Gabor analysis and Balian low	Maximilian Matthe [15]	2014	Non existenceof Zero forcing receiver	Noise enhancement and SER	Strong impact on System performance
GFDM Synchronization, windowing process	Ivan [16]	2014 SPRINGER	STO and CFO	SER	Noisy environment
Offset quadrature amplitude modulation	Ivan Gaspar [17]	2015	Low out-of-band complexity and implementation complexity	SER	limits overlapping only to the adjacent sub symbols

Pre coding technique	Zahra Sharifian [18]	2016	PAPR	BER	Computational complexity of different technique
Synchronizatio n Scheme	Danilo Gaspar [19]	2016	Symbol time offset and CFO	BER	Magnitude higher than the OFDM for the same normalized carrier frequency offset
Pulse shaping	A. kumar [20]	2017	Improve symbol error rate performance	SER	Better frequency localization
Receiver filter	Byungju Lim [21]	2017	Carrier frequency offset, Timing offset and phase noise	SIR	frequency misalignment
The feedback information is used by the turbo receiver to evaluate the channel.	Zehuna [22]	2018	The conventional algorithm does not properly employ feedback information in channel decoding..	BER, SER	Method better and mean square error performance
WFRET (Weighted type fractional Fourier transform)	Zhenduo [23]	2018	CFO ,TO	BER	Timing Error
Weighted parallel interference cancellation and adaptive cancellation filter	Byungju [24]	2018	carrier frequency offset and Timing offset Rayleigh quotient problem	SIR	Frequency misalignment
Pseudo noise	Zhenyu et. al [25]	2018	Symbol time offset and carrier frequency offset	Symbol Error rate	Reduced MSE and SER at the increase in cost
Alamouti and mimo scheme	Hao cheng [26]	2018	IQ imbalance, signal to interference imbalance and normalized complex least mean square for GFDM receiver	BER(Bit Error Rate)	BER(Bit Error Rate) Nearly saturated in the high SNR (signal to noise ratio) region

Self interference cancellation	Amirhossein [27]	2019	CFO(carrier frequency offset)and IQ(inphase quadrature) Imbalance in GFDM full duplex transceiver with the radio frequency	phase noise bandwidth, normalized CFO and IRR.	Mutual interference
Synchronization of this multicarrier technique	Siva Prasad valluri [28]	2019 IET	Investigation of blind CFO estimation and circular pulse shaping	ICI and ISI	USRP (universal software radio peripheral) makes it difficult for the receiver to match the packet to the transmitter's USRP device ID.
Matched filter	JESSICA B. SANSON [29]	2019 IEEE	in the radar processing, eliminates the effect of interference generated by the Generalized frequency division multiplexing	ICI	Limitation of time and system latency
Dual Filter	Fei Li [30]	2019 IEEE	Channel estimation and mimo system	BER	Inter symbol interference is still
Pulse shaping usingCircularly rotatingPrototype filter	Vejandla Kishore [34]	2020 IEEE	Dc biased optical GFDM	BER	Out of band radation
Index modulation technique	MengyiWang[35]	2021 IEEE	In phase quadrature	BER	Energy efficiency

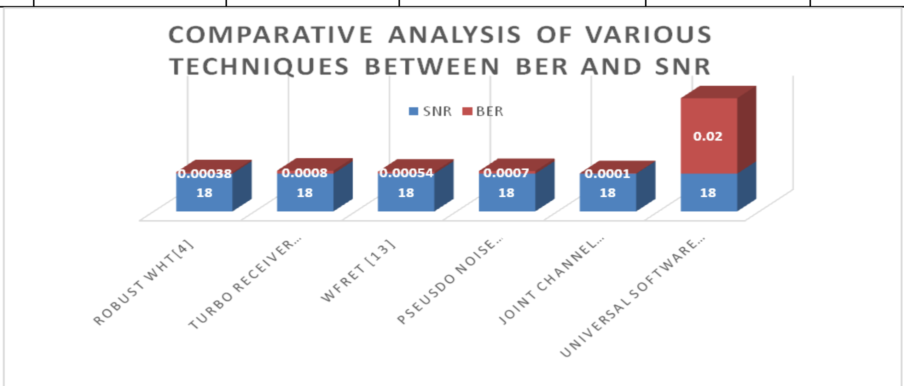

Figure 8 : Comparison chart of different techniques

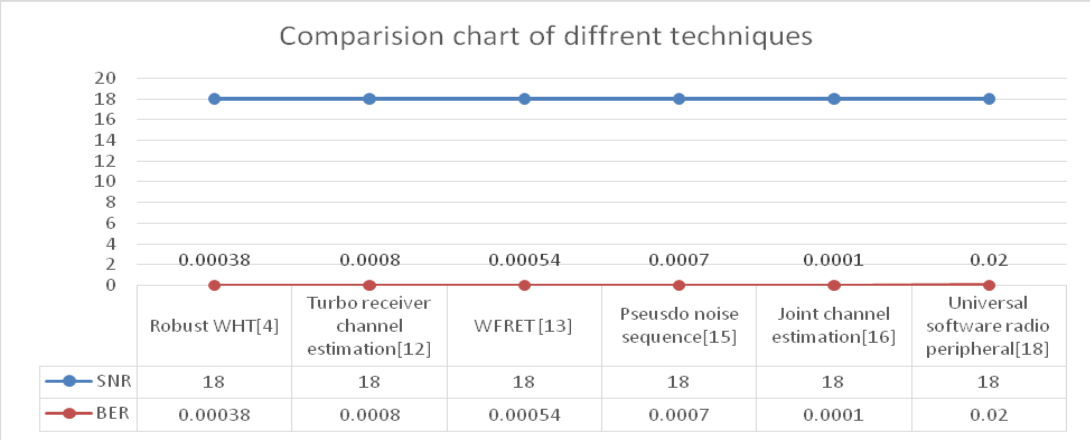

Figure 9 : Comparison chart of different techniques with table

SNR	BER	Technique
18	0.00038	Robust WHT[4]
18	0.0008	Turbo receiver channel estimation[12]
18	0.00054	WFRET [13]
18	0.0007	Pseusdo noise sequence[15]
18	0.0001	Joint channel estimation[16]
18	0.02	Universal software radio peripheral[18]

Table 2: Comparative analysis of various Techniques between BER and SNR

The figure 8 shows comparative analysis of various techniques between bit error rate (BER) and signal to noise ratio (SNR) in generalized frequency division multiplexing. There are various technique use to calculate bit error rate like Robust walsh Handmard Transform (WHT),Turbo receiver channel estimation, Weighted type fractional Fourier transform (WFRET),Pseudo noise, joint channel estimation, universal software radio peripheral.

For signal to ratio of 18db, bit error rate in Robust WHT technique is 0.00038, for Turbo receive the bit error rate is 0.0008, for WFRET the bit error rate is 0.00054, for Pseudo noise sequence it is 0.0007, for Joint channel estimation the bit error rate is 0.0001 and for Universal software radio peripheral the bit error rate is 0.02 respectively. As per above values it has been concluded that the Joint channel estimation gave the best performance.

III FILTER

Raised cosine filter (RC) is the pulse shaping filter and it is used to minimize the inter symbol interference (ISI). The impulse response of this filter as given

$$p_{RC}(t) = sinc\left(\frac{t}{T}\right)\frac{\cos(2\pi\alpha t)}{1-(2\alpha t/T)^2}$$

α is the roll off factor and T is the transmission symbol period

ROOT RAISED COSINE FILTER

In digital communication, RRC is mostly used as transmit and receive filtering. The equivalent response of these two filters is equal to that of RC filter.

$$Prrc(f)=\sqrt{|Prc(f)|}$$

The result and simulation of pulse shaping filter root raised cosine used in the GFDM model in different roll off factor The simulation result and analytical result of symbol error rate are calculated using AWGN channel, zero forcing channel and its various value of roll off factor. The simulation result obtains using software MATLAB 2019.

Table 3 Simulation parameter spectrum analysis of GFDM model

Sub-symbols (M)	4
Sub-carriers (K)	4
Mapping	qpsk
Roll off factor (α)	0.2
Channel	AWGN
Pulse shape filter	Raised cosine filter

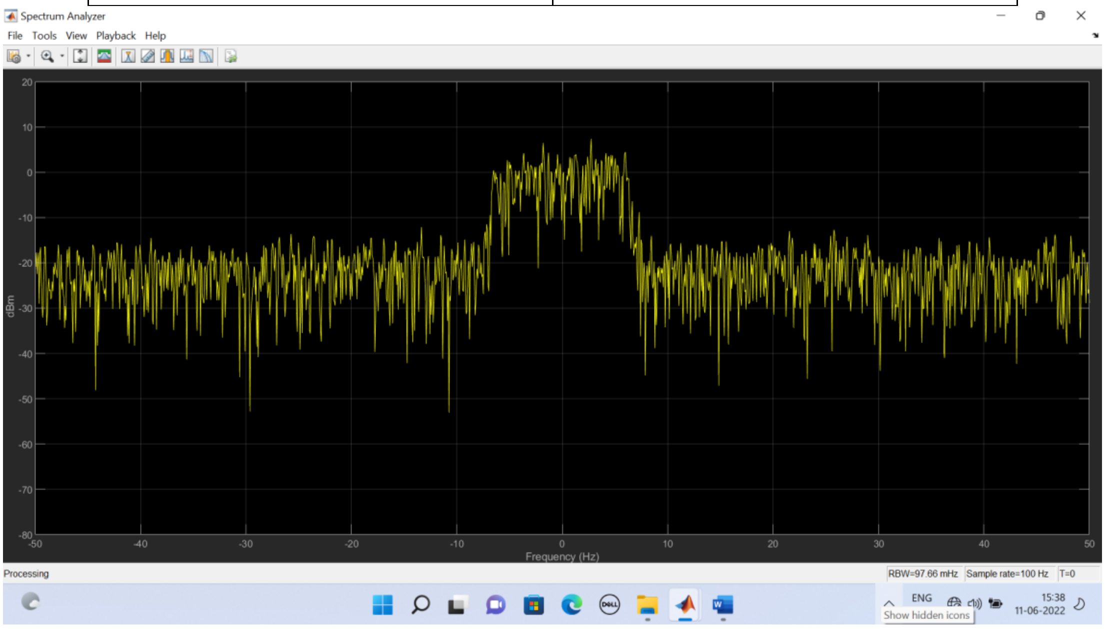

Figure 10 : Spectrum analysis of GFDM transmit signal

Spectrum analysis of GFDM transmit signal.

The figure shows spectrum analysis of GFDM system. Number of symbols is 4, number of subcarriers is 4,roll of factor is 0.2, quadrature amplitude modulation is used. In this case signal passes through additive white Gaussian noise channel and zero forcing cannel. Raised cosine filter are used to improve the performance. Here obtained symbol error rate performance is zero and observed improvement in results.

Table 4: Simulation parameter spectrum analysis of GFDM model

Sub-symbols (M)	8
Sub-carriers (K)	4
Mapping	QAM
Roll off factor (α)	0.2
Channel	AWGN
Pulse shape filter	Raised cosine filter

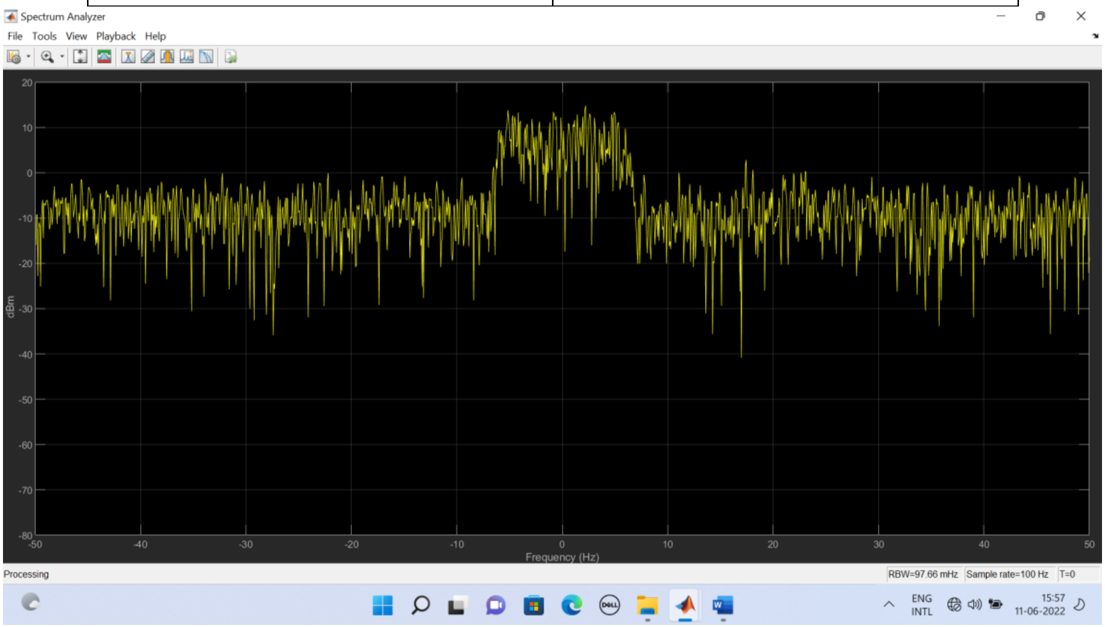

Figure 11 : Spectrum analysis of GFDM transmit signal

The figure shows spectrum analysis of GFDM system. Number of symbols is 8, number of subcarriers is 2 roll of factor is 0.2, quadrature amplitude modulation is

used. In this case signal passes through additive white Gaussian noise channel and zero forcing cannel. Raised cosine filter are used to improve the performance. Here obtained symbol error rate performance is zero and observed improvement in results.

Table 5 Simulation parameter spectrum analysis of GFDM model Through QAM Modulation

Sub-symbols (M)	64
Sub-carriers (K)	4
Mapping	QAM
Roll off factor (α)	0.2
Channel	AWGN
Pulse shape filter	root Raised cosine filter

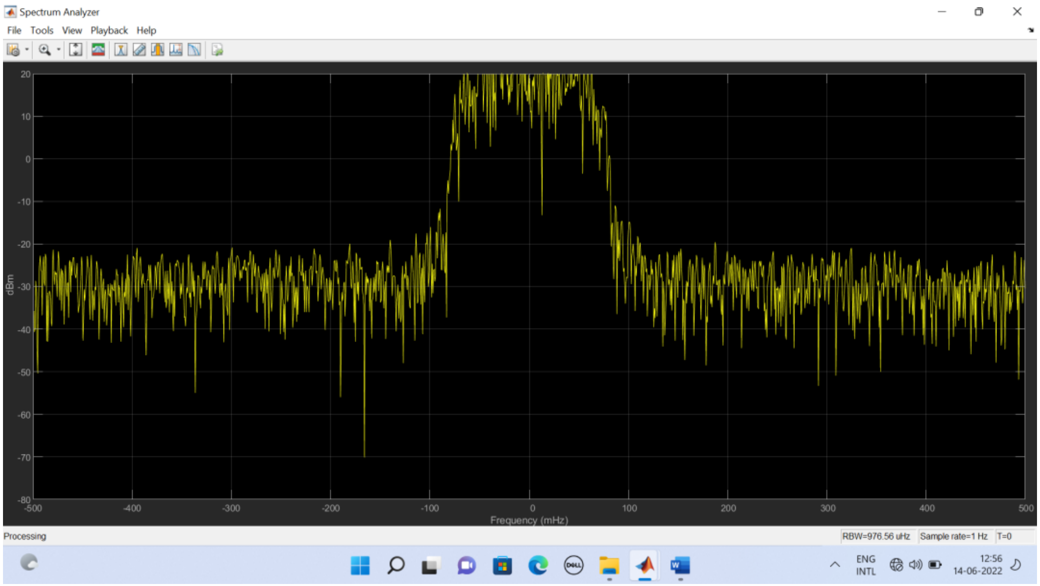

Figure 12 : Spectrum analysis of GFDM transmit signal at 0.2 roll off factor

Spectrum analysis of GFDM transmit signal the figure shows spectrum analysis of GFDM system. Number of symbols is 64, number of subcarriers is 4 ,roll of factor is 0.2, quadrature amplitude modulation is used. In this case signal passes through additive white Gaussian noise channel and zero forcing cannel. Root Raised cosine filter are used to improve the performance. Here obtained symbol error rate performance is zero and observed improvement in results.

Figure 13: Simulation result of symbol error rate Versus signal to noise ratio with root raised cosine filter in GFDM.

Simulation result of symbol error rate Versus signal to noise ratio with root raised cosine filter in GFDM.

The figure 6 shows x axis represent roll off factor and y axis represent mean symbol error rate. 0.1 roll off factor get symbol error rate 0.5 and 0.15 roll off factor

get symbol error rate 0.48, 0.2 roll off factor get symbol error rate 0.46 and 0.3 roll off factor get symbol error rate 0.42. Here obtained improvement result.

Figure 14 : Simulation result of mean symbol error rate versus different roll off factor

Simulation result of mean symbol error rate Versus roll off factor with root raised cosine filter in GFDM

The figure 6 shows x axis represent roll off factor and y axis represent mean symbol error rate. 0.1 roll off factor get symbol error rate 0.13 and 0.15 roll off factor get symbol error rate 0.12, 0.2 roll off factor get symbol error rate 0.11 and 0.3 roll off factor get symbol error rate 0.11. Here obtained improvement result.

I. Conclusions

In the paper, mainly focused on different algorithm and technique used in GFDM using 5G technology to reduce ISI (inter symbol interference), BER (bit error rate) , SER(Symbol error rate) and also focused that spectrum analysis, roll off factor and symbol error rate,signal to noise ratio done using pulse shaping raised cosine and root raised cosine filters. Simulation results for spectum analysis and Symbol Error rate are reported. Recently, the performance of GFDM has been improved with the assistance of a new algorithm, allowing for various works to be carried out with implementation and its non-linear behavioral effects of GFDM.

IV. References

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