Investigation and Evaluation of Multi-Carrier Air Interfaces for L-Band and C-Band in CR Air to Ground Coordination

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***Abstract*— In airport environment, C-band is utilized for transmission as per EUROCONTROL and FAA which uses other technique namely Orthogonal Frequency Division Multiplexing which is termed as Aero MACS, furnish the extending need of communication traffic in airport surrounding .Initially, Our purposed system objective is to investigate and analyse the OFDM of existing procedure and FBMC of proposed methodology in A/G communication systems in L-band ,C-band and study the application of FBMC technique in the efficient aviation bands and match the methodology of both proposed and existing technique. Hence, it is known that, FBMC in air to ground coordination is initiated and it is utilized in this dissertation at first though FBMC can provide more advantages, when compared with OFDM. Sharp filters are used in FBMC technique from which band interference is turn down. Distance measurement equipment (DME) is more robust to high-power interference, whereas 23% of greater throughput can be yield using FBMC technique.**

Keywords—FBMC,OFDM,AeroMACS,A/G communication.

I. INTRODUCTION (*HEADING 1*)

More capable communication system needs to meet the larger scale air traffic densities in future.VHF aviation bands (118 to 137 MHz) are used to communicate the data between the pilots and air traffic controllers which use Double-Sideband Amplitude Modulation (DSB-AM) as its link though it is becoming congested worldwide. Here comes the need for alternative spectral bands and new communication techniques to meet future demands. Multi-carrier (MC) modulations have implemented and used to acquire high data rate in transmission of frequency and time domain channel. The Air Ground communication takes place in the order as shown Fig:1.

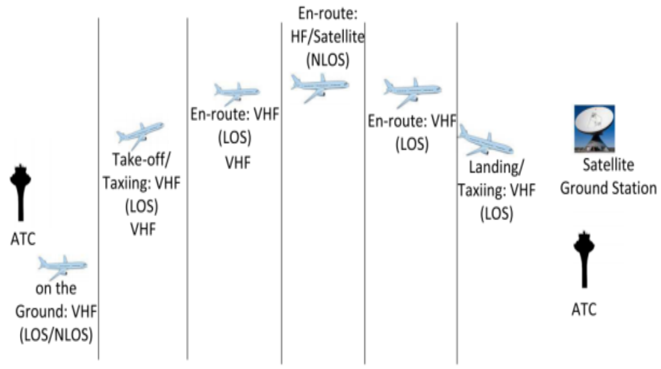

Fig:1. ***Preferred operating bands in different phases of flight for A/G communications***

II. LITERATURE SUREY

The two connection arrangements in the Broadcast (ADS-B) administrations which is the actual surface of the programmed subordinate observation are General access Handset (GAH) and Mode S [1]. The airplane decides its position through satellite route and occasionally communicates it, empowering it to be followed in an observation innovation advertisement B. The data can be gotten via aviation authority base stations which is a optional radar substitution . Likewise the further airplane can give specific mindfulness and permit own-division [2]. Advertisements B has "programmed" as it does not require any pilot or outside info. The airplane's route framework provides information to the advertisement B. The different standby-diverts in the OFDM is balancing with the RRC shifting got utilized by the air interfaces. The broadband VHF (B-VHF) which is a modern multicarrier based aviation framework depends on the MC-CDMA procedure [4]. EUROCONTROL and FAA entrusted the radio band air to ground multi-transporter correspondences framework (B-AMC) combined to adjust the B-VHF framework to L-band utilize and operate examinations to choose whether and by what method a potential B-VHF framework could be worked in L-band [5]. Spectrum sensing is an essential part of CR which enable the user to sense the White and Grey spaces in RF environment. This paper enlightens the method of spectrum sensing, the recent advancements and the problems

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associated with the efficient use of it[10]. Integrated with ground radio stations and centralized management system, the CR can dynamically use the available channels based on its actual location, environment condition, and, therefore, maximize the use of the limited spectrum [11]. Air Station can reliably cancel the interference, and the spectrum efficient non-orthogonal transmission schemes can achieve better diversity order than orthogonal transmission systems [12]. This paper proposed a novel nonlinear constellation pre-coding (NCP) technique based on maximum distance separable (MDS) codes in orthogonal frequency-division multiplexing (OFDM) systems [13].

III. PROPOSED SYSTEM SYSTEM ARCHITECTURE

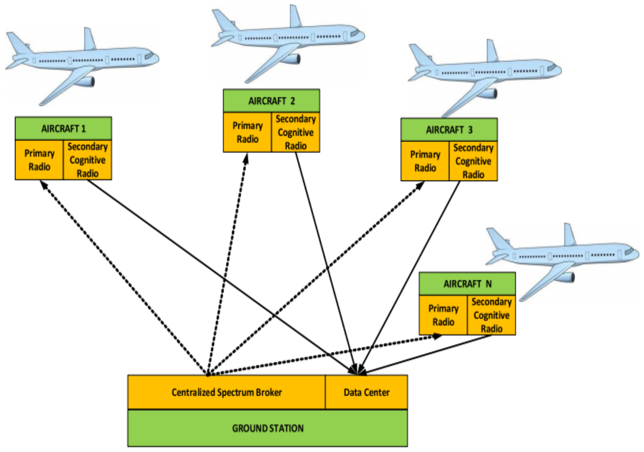

Fig 2. CRN with Air band interference

Primarily, CRN is a wireless communication which has its origin at early 2000s having a transceiver embedded with transmitter and receiver.CRN acts as a intelligent device which also very useful to detect the empty channel and make other users to use the chancel by providing accessibility. Frequency band users are classified as Primary and Secondary users. In this dissertation, each aircraft has a frequency band of both primary and secondary users which cause a interference in communication.

The communicating power is similarly distributed among all s ubcarriers in our previous FBMC correspondence framework plan (like LDACS1 and practically Orthogonal Frequency DivisionMultiplexing frameworks), as shown in Fig:2.We inv estigated the thinking and capability of an inconsistent force di spersion in the midst of subcarriers, at the point appropriation is dependent to theparticular channel, in light of the perception that channel conditions can differ for various subcarriers.

In our L-band A/G case, it has been found that, a portion of the edge FBMC subcarriers have a high force D ME signal range, and we expect these subcarriers to have a hig her BER than subcarriers with much lower DME impedance le vels. Secondary architecture on-board To be realistic, a BER floor may be encountered by some of these subcarriers. In reenactments, we agreed with this perception. We depart from the equivalent force per subcarrier display in what we call frightfully shaped FBMC (SS-FBMC) and examine this as another way to moderate DME impedance. For various QAM adjustment requests and channels, we propose a technique for determining the appropriate watchman subcarriers and enhancing the measure of apportioned force for each leftover subcarrier to get the best BER execution with no mistake floor. We enhance the correspondence framework's efficacy and execution in this way, with only a slight rise in unpredictability.

We had used SS-FBMC principle as a solid methodology for L-band AG intellectual radio based correspondence frameworks in one of our most recent study. Over the last few years, psychological radio has been researched [97-100]. The overwhelming majority of the exams have been completed for organizations in earthbound and remote provincial regions (Wireless Region Area Network). The IEEE 802.22 is defined characterized in VHF/UHF TV groups somewhere between 54 and 862 MHz, is the most unmistakable intellectual radio standard. We explored the possibilities of using psychological radio innovation for Air to Ground correspondence frameworks using the SS-FBMC method and our new work depicted in this section, the DME signal interference over the FBMC signal at the destination is,

$$\mathbf{r(t)= \sum_{m=0}^{N-1} x_m(t)+ i(t)+n(t)} \qquad \mathbf{(1)}$$

i. i(t) =DME signal,

ii. \n(t)=AWGN (power) obtain in Practical SNRs.

The state of subcarrier m after undergoing down conversion as follows,

$$\mathbf{r_m(t)=(x_m(t)+ i(t) + n(t))e^{-jm(2\pi/T * t+\pi/2)}}$$

(2)

$$r_m(t) = \sum_{l=-\infty}^{\infty}\left(s_m^I[l]h(t-lT) + js_m^Q[l]h(t-lT-T/2)\right) + i(t)e^{-jm\left(\frac{2\pi}{T}t+\frac{\pi}{2}\right)} + n(t)e^{-jm\left(\frac{2\pi}{T}t+\frac{\pi}{2}\right)}$$

(3)

Taking real and imaginary parts of every subcarrier becomes ,

$$Real(r_m(t)) = \sum_{l=-\infty}^{\infty}\left(s_m^I[l]h(t-lT)\right) + i(t)cos(m(\frac{2\pi}{T}t+\frac{\pi}{2})) + Real\left(n(t)e^{-jm\left(\frac{2\pi}{T}t+\frac{\pi}{2}\right)}\right)$$

(4)

$$Imag(r_m(t)) = \sum_{l=-\infty}^{\infty}\left(s_m^Q[l]h(t - lT - T/2)\right) + i(t)sin(m(\frac{2\pi}{T}t + \frac{\pi}{2})) + Imag\left(n(t)e^{-jm\left(\frac{2\pi}{T}t+\frac{\pi}{2}\right)}\right) \quad \textbf{(5)}$$

Then using prototype filtering equation **(4) and (5)**,

$$\text{Real }(rm(t))*h(t) \quad (6) \quad \&$$

$$\text{Imag }(rm(t))*h(t+T/2)$$

i. h(t)= symbol of prototype filter
ii. t=n T, sampled at time

Presume channel estimation and perfect synchronization, value of m subcarrier,

$$\hat{s}_m^I[n] = s_m^I[n] + I_{Real} + n_{Real}$$

$$\hat{s}_m^Q[n] = s_m^Q[n] + I_{Imag} + n_{Imag} \quad \textbf{(7)}$$

In Equation **(7),** taking into account of the real and imaginary parts of DME interference is denoted in second term and then noise is denoted in third term respectively. For the interference terms we obtain,

$$I_{Real} = i(t)cos\left(m\left(\frac{2\pi}{T}t + \frac{\pi}{2}\right)\right) * h(t) \quad \textbf{(8)}$$

$$I_{Imag} = i(t)sin\left(m\left(\frac{2\pi}{T}t + \frac{\pi}{2}\right)\right) * h(t + T/2) \quad \textbf{(9)}$$

IV.RESULT

The Existing approach of OFDM, its performance is compared with Rayleigh channel and AWGN channel which is designed with SS-FBMC is evaluated.

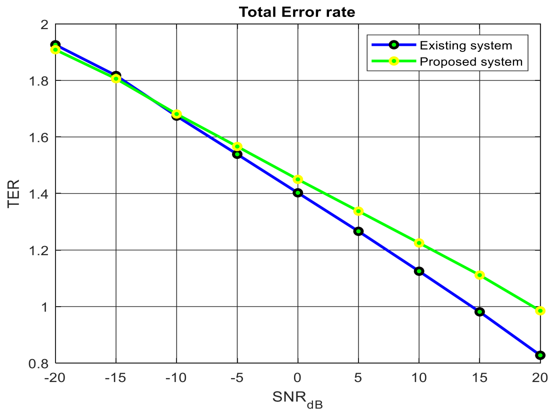

Fig :3 Error Rate of the data transmitted between OFDM and FBMC with SNR and TER.

The blue dotted line of this graph explains the error rate that is observed when use of OFDM (existing) system and green dotted lines of this graph explains the error rate that is evaluated by using a FBMC technique. The error rate of both the system is illustrated in Fig :3 which shows that FBMC technique has lesser amount of error per data transmitted.

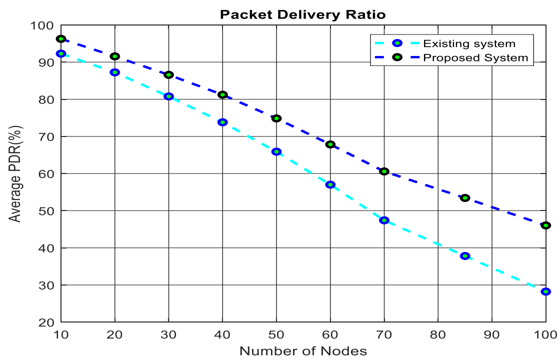

Fig:4 Packet Delivery Ratio is shown as No. of nodes and average (PDR) delivery ratio of packets from OFDM and FBMC is compared and put together to evaluate the PDR.

Fraction of aggregate packets data that is received at destinations to the aggregate packets data transmitted from sources is called Packet Delivery Ratio. This figure 5, express the number of nodes and average PDR in this x-axis and y-axis demonstrating our existing (OFDM) and proposed (FBMC) system.

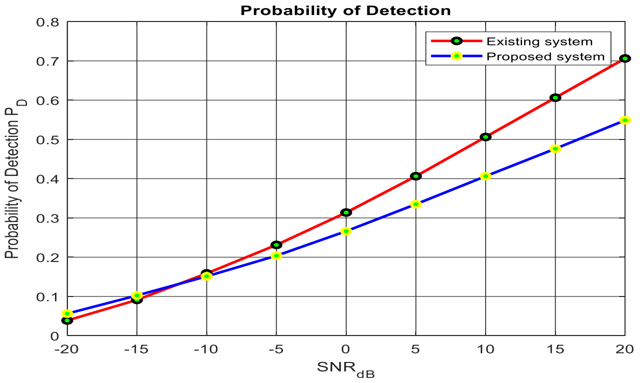

Fig :5 Probability of Detection between SNR and the data that are received at destintion.

P_D is defined as the fraction of spotted aims every possible blips on the radar screen. Here the dotted lines of graph depicts the probability of data that is send to a receiver end and the amount of data that are received as such in both of our OFDM and FBMC technique simulation . The red dotted graph clearly explains the no. of data that is send and receive receives that data lesser in accuracy than the blue dotted lines of FBMC system of considering the SNR and P_D as its framework respectively.

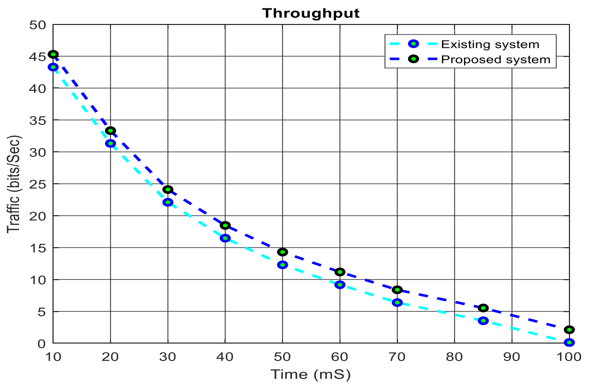

Fig:6 Throughput of techniques OFDM & FBMC

Throughput is the actual amount of data that is successfully transmitted or received over the communication link. Our goal is to bring the throughput higher than the existing technique of OFDM is achieved by using FBMC in A/G communication along with time(ms) and Traffic(bits/sec) .

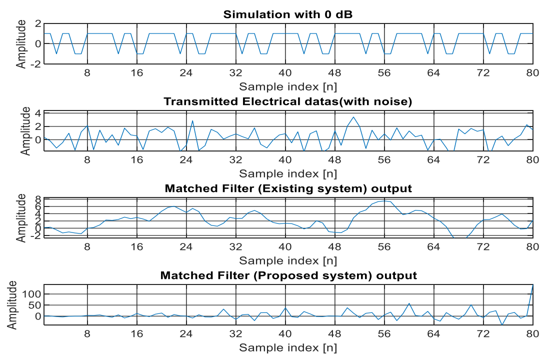

Fig:6 Simulation with 0db in interference cancellation.

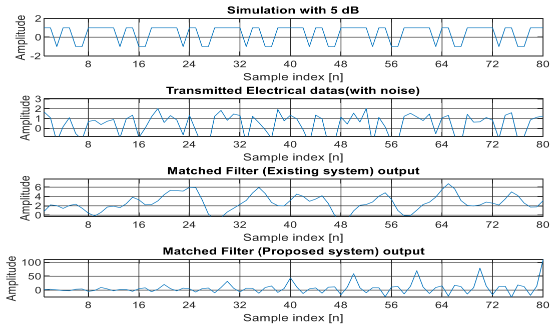

Fig:7 Simulation with 5db in interference cancellation.

The 1st subplot of the simulation depicts the input signal that has been generated in CR. The 2nd subplot of the simulation shows the AWGN noise that is generated. The 3rd subplot of the simulation displays the outcome of OFDM system of matched filter which is existing and the 4th subplot of the simulation present output of FBMC system respectively where the interference in the input is reduced when compared to matched filters of OFDM technique.

V.CONCLUSION

The Principal objective of our dissertation is to investigate existing (OFDM) and proposed (FBMC) aviation communication systems in L-band, C-band and study the use of multicarrier techniques in these aviation bands and match the multicarrier technique OFDM with the Filter Bank Multi Carrier (FBMC) technique. Multi-carrier (MC) modulations has implemented and used to acquire high data rate in transmission of frequency and time domain channel .It will also build a scope of correspondence to the excellence of its decrease of the DME signal impedance FBMC can provide greater throughput than the contending OFDM by up to 23% and also offers advantages over AeroMACS. Comparison between Existing and Proposed system is evaluated and tabulated respectively.

VI.FUTURE WORK

As we propose using FBMC technique in order to reduce the interference. In future, with the help of Machine Learning technique of fuzzy logic algorithm we can minimize the interference and also can improve the throughput about few percentages when compared to OFDM and FBMC techniques.

REFERENCE

[1] Broadband VHF Aeronautical Communications System based on MC-CDMA (Jan 2004) [Online]. Available: http://www.b-vhf.org.

[2] M. Schnell et al., “B-AMC - broadband aeronautical multi-carrier communications,” 2008 Integrated Communications Navigation and Surveillance Conference (ICNS), pp. 1-12, Bethesda, MD, 5-7 May 2008.

[3] H. Jamal, D. W. Matolak, R. Sun, “Comparison of L-DACS and FBMC performance in over-water air-ground channels,” Proc. IEEE/AIAA 34th Digital Avionics Systems Conference (DASC), pp. 2D6-1, Prague, Czech Republic, 13-17 Sept. 2015.

[4] H. Jamal, D.W. Matolak, “FBMC and LDACS Performance for Future Air to Ground Communication Systems," IEEE

Transactions on Vehicular Technology, vol. 66, no. 99, pp. 5043-5055, June 2017.

[5] R. Chang, "High-speed multichannel data transmission with bandlimited orthogonal signals," Bell Sys. Tech. J., vol. 45, pp. 1775-1796, Dec. 1966.

[6] B. Saltzberg, "Performance of an efficient parallel data transmission system," IEEE Trans. on Comm. Tech., vol. 15, no. 6, pp. 805-811, Dec. 1967.

[7] ITT Industries, "Technology Assessment for the Future Aeronautical Communications System," NASA/CR-2005-213587, TR04055, Reston, VA, May 2005.

[8] IEEE Standards Association,IEEE 802.16,website:http://standards.ieee.org/getieee802/802.16.html,2 March 2017

[9] Muthalagu Raja "Application of cognitive radio and interference cancellation in the L-band based on future air-ground communication systems"volume 5,issue to,May2019.

[10] Dharmendara kumar Fageria , Rahul Kumar Garg, "Analysis on cognitive radio based spectrum sensing techniques" ,June 2018.

[11] Y.Wang "CR for Aeronautical air to ground communication",2010.

[12] Rajendra Prasad Sirginia.A.S.Madhukumar,A.O.Vinod"Cancellation of interference in cognitive radio A/G communications'',2016.

[13] P.Muthuchidambaranathan,M.Raja"NCP techniques for OFDM Subcarrier Systems",December 2013.