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A detailed analysis of performance of Digital audio broadcasting under different channels

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Abstract-

The paper is trying to develop a novel scheme of low cost, complexity wise reduced communication model for open air performance analysis. This paper presents digital radio broadcasting Eureka 147 standard, which works at four different operating modes. Thus the paper implements a quite novel method for the purpose of quality improvement in the communication equipment improvement using DAB. The results that has been performed on different types of channels are additive white Gaussian noise, Rayleigh and Rician fading channels. Of all the different types of channels in MATLAB software for which a complete detailed table analysis has been done has found that of all the possible four modes the fourth mode has outperformed with good level of BER performance ranging between 20% to 22%.

I. Introduction.

Digital Audio Broadcasting (DAB) was produced inside of the European Eureka-147 standard [1] to give CD quality sound projects alongside subordinate information transmission (e.g. travel and activity data, still and moving pictures, and so on.) to settled, convenient and portable collectors utilizing basic whip receiving wires [2]. In 1995, ETSI (European Telecommunications Standards Institute) received DAB as the main European standard for digital radio. The acceptance standard of simple AM/FM frameworks on versatile radio is severely influenced by Multipath blurring (reflections from flying machine, vehicles, structures, and so forth.) and shadowing [3]. These frameworks additionally experience the ill effects of impedance from gear, vehicles and other radio stations. DAB utilizes coded orthogonal recurrence division multiplexing (COFDM) innovation to battle the impacts of Multipath blurring and bury image impedance (ISI). Also the VHF recurrence band accessible for the sound television all through the world has either immersed or quick drawing closer immersion. There is a requirement for all the more frightfully productive television innovation separated from ordinary simple frameworks. Since DAB utilizes OFDM innovation in this manner the framework can work in single recurrence systems (SFNs) giving the effective utilization of accessible radio frequency range. In this paper we added to a DAB base-band transmission framework taking into account Eureka-147 standard [1]. In the transmitter section, forward error correction, OFDM signal generator, QPSK symbol mapper, energy dispersal scrambler are configured. In this project transmission mode I,II,III,IV are implemented. Bit error rate (BER) has been evaluated in different transmission modes in different channels. The analysis has been done under MATLAB environment. The remaining part of the paper is sorted out as takes after. Part II presents the DAB framework standard. Part III defines brief description of the DAB framework. In part IV, the modelling and simulation is discussed using MATLAB. In Part V, the simulation results are defined. In the last part VI describes the conclusions and future work

.II. INTRODUCTION TO DAB SYSTEM

The working concept of the DAB framework is outlined in theoretical block description appeared in Fig. 1. At the information of the system the analog information, for example, sound and data services are MPEG layer-II encoded and after that mixed. Keeping in mind the main goal to maintain the proper energy dispersal in the transmitted information and the specific inputs of the energy spreading scramblers is associated by modulo-2 adder with a pseudo-random binary sequence (PRBS), before convolutional coding [1]. The associated bit stream is then directed to forward error correction (FEC) utilizing punctured convolutional codes with code rates in the boundary of 0.25-0.88. The coded bit-stream is then time interleaved and multiplexed with different projects to frame Main Service Channel (MSC) in the primary administration multiplexer. The turnout of the multiplexer is then connected with service data in the Fast Information Channel (FIC) to frame the DAB frame structure. At that point after QPSK mapping with frequency interleaving of every subcarriers in the system, $\pi/4$ moved differential QPSK balance is performed. At that point the outcome of FIC and MSC symbol generator alongside the Phase Reference Symbol (PRS) which is a devoted pilot image created by square named synchronization image generator is gone to OFDM signal generator. This part is the heart of the DAB framework. At long last, the expansion of Null image to the OFDM signal finishes the last DAB Frame structure for transmission.

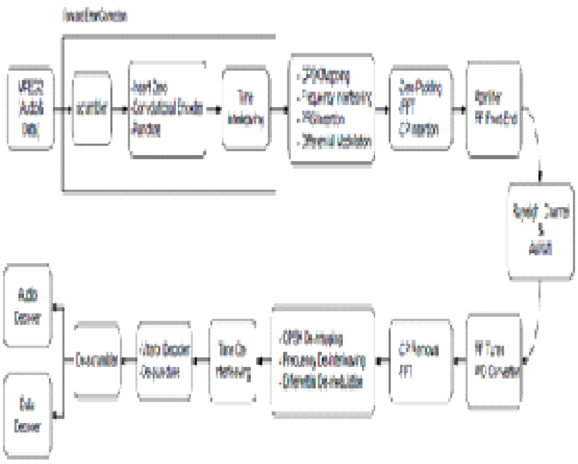

Figure 1. Complete DAB transmitter system

Channel coding, muliplexing and transmission outline.

The channel coding depends on a convolutional code with requirement length 7. The octal types of the generator polynomials are 133, 171, 145 and 133, individually. The mother code has the code rate R =1/4, that is for every information bit ai the encoder produces four coded bits x0,i, x1,i, x2,i, and x3,i. The unique project (audio and information) are at first encoded, error secured by applying FEC and after that time interleaved. These outputs are then joined together to plan a singular information stream prepared for transmission. This procedure is called as Multiplexing. In DAB a few projects are multiplexed with a data transmission of 1.536 MHz. The frame structure of the DAB signal is appeared in Fig. 2 that assists in well organized recipient synchronization. The period of DAB transmission frame is of 24 ms.

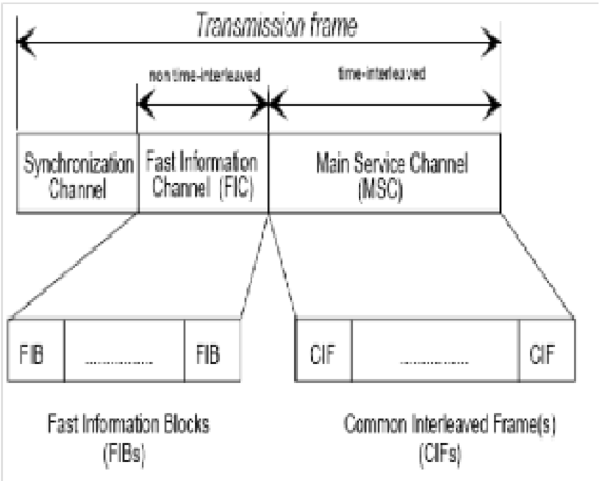

Fig-2 DAB Transmission Frame

COFDM-DAB utilizes COFDM innovation that makes it impervious to multipath fading impacts and (ISI). OFDM is imitative from the way that the high serial piece stream information is transmitted over expansive (parallel) number sub-carriers (acquired by partitioning the accessible data transfer capacity), each of a diverse frequency and these carriers are orthogonal to each other. OFDM changes frequency selective fading channel into N flat fading channels, where N is the fraction of sub-carriers. Orthogonality is kept up by keeping the carrier separating numerous of 1/Ts by utilizing Fourier transfer techniques, where Ts is the symbol period. Since channel coding is connected preceding OFDM symbol formation which represents the expression "coded" in COFDM.

Transmission mode-1 is intended for enormous field coverage. It is suited for single frequency networks (SFNs) working at frequencies beneath 300 MHz (VHF Band-III).

Transmission mode-2 is planned conceptually for Terrestrial DAB for little to medium scope territories at frequencies beneath 1.5 GHz (UHF L-Band).

DAB Transmission modes-

The Eureka 147 DAB [1] framework has four transmission methods of operation named as mode-I, mode-II, mode-III, and mode-IV, each having its specific arrangement of parameters as appeared in Table-I

SYSTEM PARAMETERS FOR THE FOUR DAB MODES

	Transmission Mode-I	Transmission Mode-II	Transmission Mode-III	Transmission Mode-IV
No of sub carriers	1536	384	192	768
OFDM symbols/frame	76	76	153	76
Transmission frame duration	196608 T	49152 T 24 ms	49152 T 24 ms	98304 T 48 ms
Null symbol duration	2656 T 1297 ms	664 T 324 μs	345 T 168 μs	1328 T 648 μs
OFDM symbol duration	2552 T 1246 ms	638 T 319 μs	319 T 156 μs	1276 T 638 μs
Inverse of carrier spacing	2048 T 1 ms	512 T 250 μs	256 T 125 μs	1024 T 500 μs
Guard Interval	504 T 246 μs	126 T 62 μs	63 T 31 μs	252 T 123 μs
Max RF	375 MHz	1.5 GHz	3 GHz	750 MHz
Sub Carrier Spacing	1 KHz	4 KHz	8 KHz	2 KHz
FFT length	2048	512	256	1024

Transmission mode-3 is accessible for satellite television beneath 3 GHz (UHF L-and).

Transmission mode-4 is utilized for consistent scope of expansive regions by method for SFNs working in the L-Band. The parameters of Mode IV lie between those of Mode-I and Mode-II.

III. THE SIMULATION MODEL-

Fig. 3 exhibits the complete block diagram of the DAB framework which was demonstrated and recreated by us in MATLAB environment. The primary goal of this simulation study is to calculate the BER execution of the DAB framework utilizing connected coding system. The recreation parameters are attained from Table I for transmission mode-I,II,III,IV. A casing based handling is utilized as a part of this recreation model. The project model was presented to AWGN channel, Rayleigh blurring channel and Rician channel for execution examination. The essential blocks of the recreation model is talked about in subtle element as takes after: Scrambler-

With a specific end goal to guarantee proper energy dispersal in the transmitted signal, the individual inputs of the energy dispersal scramblers appeared in Fig 3. might be mixed by a modulo-2 expansion with a pseudo-irregular paired arrangement (PRBS), preceding convolutional encoding. The PRBS might be characterized as the output of the feedback shift register and should utilize a polynomial of degree 9, characterized by Viterbi decoding-

$$P(X) = X^9+X^5+1 \quad (1)$$

To minimize the transmission errors because of channel hindrances the DAB in the transmitter utilized intense rate perfect punctured convolutional code (RCPC) with imperative length 7 and mother code rate of 1/4 for channel coding. For decoding these codes the Viterbi calculation will be utilized, which offers best execution as per the most extreme probability criteria. The data to the Viterbi decoder will be hard-chosen bits that are "0" or '1', which is alluded to as a hard choice. Computational necessities or multifaceted nature of Viterbi decoder develop exponentially as an element of the requirement length (L), so it is normally restricted practically speaking to limitation length of L = 9 or less.

Rayleigh and Rician Fading Model-

The figure 3 delineates immediate and major reflected ways between a stationary radio transmitter and a moving recipient. The shaded shapes speak to reflectors, for example, structures. The significant ways result in the occurrence of lagging versions of the signal at the recipient. After that, the radio signal experiences dissipating on a nearby scale for every significant path. Such near by dissipating is ordinarily described by a substantial number of reflections by articles close to the mobile. These irresolvable parts join at the recipient and offer ascent to the marvel known as multipath blurring. Because of this phenomenon, every real way carries on as a discrete blurring way. Commonly, the blurring procedure is portrayed by a Rayleigh appropriation for a nonline-of-sight way and a Rician circulation for a viewable pathway way. The relative movement between the transmitter and receiver causes Doppler movements. Nearby spreading normally originates from numerous points around the mobile. This situation causes a scope of Doppler movements, known as the Doppler range. The most extreme Doppler movement relates to the nearby scrambling segments whose bearing precisely restricts the mobile's direction.

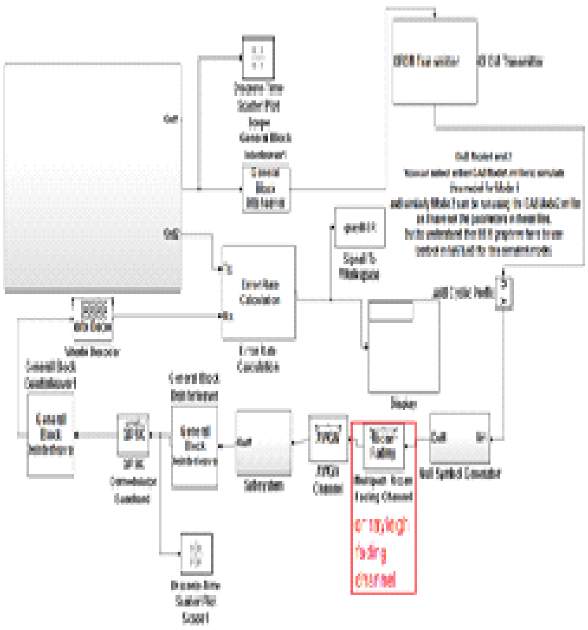

Fig-3 DAB simulink Model

IV. SIMULATION RESULTS AND DISCUSSION-

In this area we have introduced the simulation results alongside the BER evaluation for AWGN, Rayleigh fading channel and Rician channel. The outcomes are appeared for transmission mode-I,II,III and IV and the simulation parameters are taken according to the DAB standard.

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Table-II Error rate calculation for Mode-I in Rician Fading Channel by varying the Doppler frequency

SNR	Doppler Shift	Error Rate	Received bits	Transmitted bits
50 dB	10 Hz	.2457	749	3048
50 dB	20 Hz	.2457	749	3048
50 dB	30 Hz	.2457	749	3048
50 dB	40 Hz	.2457	749	3048

Table-III Error rate calculation for Mode-II in Rician Fading Channel by varying the Doppler frequency

SNR	Doppler Shift	Error Rate	Received Bits	Transmitted Bits
50 dB	10 Hz	.2567	191	744
50 dB	20 Hz	.2567	191	744
50 dB	30 Hz	.2567	191	744
50 dB	40 Hz	.2567	191	744

Table-IV Error rate calculation for Mode-III in Rician FadingChannel by varying the Doppler frequency

SNR	Doppler Shift	Error Rate	Received Bits	Transmitted Bits
50 dB	10 Hz	.3424	189	552
50 dB	20 Hz	.3424	189	552
50 dB	30 Hz	.3424	189	552
50 dB	40 Hz	.3424	189	552

Table-VI Error rate calculation for Mode-I in Rician Fading Channel by varying the Noise

SNR	Doppler Shift	Error Rate	Received Bits	Transmitted Bits
10 dB	40 Hz	.249	759	3048
20 dB	40 Hz	.2392	729	3048
30 dB	40 Hz	.2467	752	3048
40 dB	40 Hz	.2457	749	3048

Table-VII Error rate calculation for Mode-II in Rician Fading Channel by varying the Noise

SNR	Doppler Shift	Error Rate	Received Bits	Transmitted Bits
10 dB	40 Hz	.246	183	744
20 dB	40 Hz	.254	189	744
30 dB	40 Hz	.2567	191	744
40 dB	40 Hz	.2567	191	744

Table-VIII Error rate calculation for Mode-III in Rician Fading Channel by varying the Noise

SNR	Doppler Shift	Error Rate	Received Bits	Transmitted Bits
10 dB	40 Hz	.3297	182	552
20 dB	40 Hz	.3442	190	552
30 dB	40 Hz	.3478	192	552
40 dB	40 Hz	.3424	189	552

Table-IX Error rate calculation for Mode-IV in Rician Fading Channel by varying the Noise

SNR	Doppler Shift	Error Rate	Received Bits	Transmitted Bits
10 dB	40 Hz	.2447	370	1512
20 dB	40 Hz	.2385	353	1512
30 dB	40 Hz	.2401	363	1512
40 dB	40 Hz	.2388	361	1512

Table-X Error rate calculation for Mode-I in Rayleigh Fading Channel by varying the Noise

SNR	Doppler Shift	Error Rate	Received Bits	Transmitted Bits
10 dB	40 Hz	.2493	760	3048
20 dB	40 Hz	.2362	720	3048
30 dB	40 Hz	.2484	757	3048
40 dB	40 Hz	.2457	749	3048

Table-XI Error rate calculation for Mode-II in Rayleigh Fading Channel by varying the Noise

SNR	Doppler Shift	Error Rate	Received Bits	Transmitted Bits
10 dB	40 Hz	.2419	180	744
20 dB	40 Hz	.2540	189	744
30 dB	40 Hz	.2567	191	744
40 dB	40 Hz	.2567	191	744

Table-XII Error rate calculation for Mode-III in Rayleigh Fading Channel by varying the Noise

SNR	Doppler Shift	Error Rate	Received Bits	Transmitted Bits
10 dB	40 Hz	.3297	182	552
20 dB	40 Hz	.3442	190	552
30 dB	40 Hz	.3424	189	552
40 dB	40 Hz	.3424	189	552

Table-XIII Error rate calculation for Mode-IV in Rayleigh Fading Channel by varying the Noise

SNR	Doppler Shift	Error Rate	Received Bits	Transmitted Bits
10 dB	40 Hz	.2401	363	1512
20 dB	40 Hz	.2348	355	1512
30 dB	40 Hz	.02401	363	1512
40 dB	40 Hz	.02388	361	1512

Table-XIV Error rate calculation for Mode-I in Rayleigh Fading Channel by varying the Doppler frequency

SNR	Doppler Shift	Error Rate	Received bits	Transmitted bits
50 dB	10 Hz	.2464	751	3048
50 dB	20 Hz	.2464	751	3048
50 dB	30 Hz	.2464	751	3048
50 dB	40 Hz	.2464	751	3048

Table-XV Error rate calculation for Mode-II in Rayleigh Fading Channel by varying the Doppler frequency

SNR	Doppler Shift	Error Rate	Received Bits	Transmitted Bits
50 dB	10 Hz	.2567	191	744
50 dB	20 Hz	.2567	191	744
50 dB	30 Hz	.2567	191	744
50 dB	40 Hz	.2567	191	744

Table-XVI Error rate calculation for Mode-III in Rayleigh Fading Channel by varying the Doppler frequency

SNR	Doppler Shift	Error Rate	Received Bits	Transmitted Bits
50 dB	10 Hz	.3442	190	552
50 dB	20 Hz	.3442	190	552
50 dB	30 Hz	.3442	190	552
50 dB	40 Hz	.3442	190	552

Table-XVII Error rate calculation for Mode-IV in Rayleigh Fading Channel by varying the Doppler frequency

SNR	Doppler Shift	Error Rate	Received Bits	Transmitted Bits
50 dB	10 Hz	.2388	361	1512
50 dB	20 Hz	.2388	361	1512
50 dB	30 Hz	.2388	361	1512
50 dB	40 Hz	.2388	361	1512

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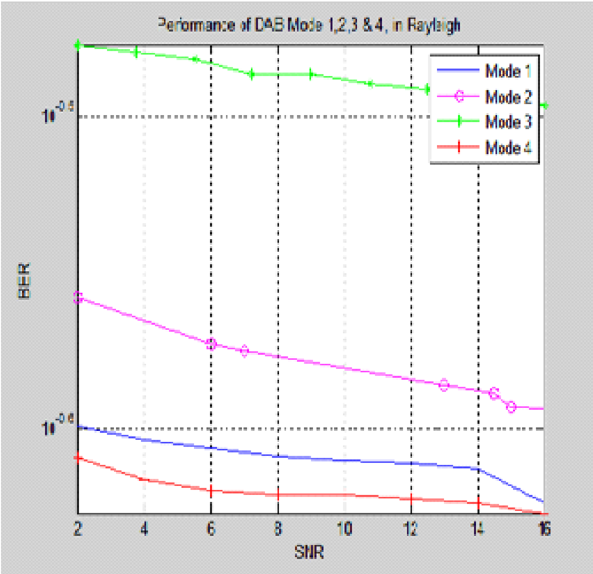

Fig-4 Performance of DAB Mode 1,2,3 & 4 in Rayleigh Channel

According to fig-4 Mode-IV is the best in all modes for Rayleigh channel. The

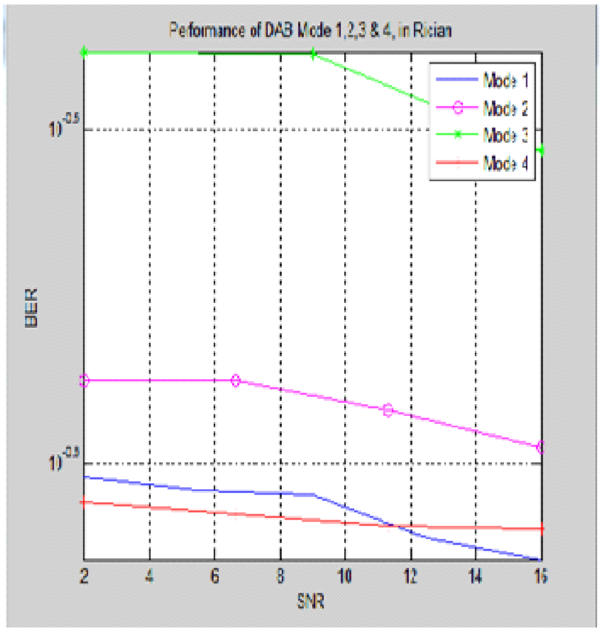

Fig-5 Performance of DAB Mode 1,2,3 & 4 in Rician Channel

In figure-5 Mode-4 is better but after 12 dB of SNR Mode-1 is providing better BER graphs.

VI- Conclusion

The paper proposes a novel digital audio broadcasting technique which uses a conventional modulation technique that offers wide flexibility in the system selection. The compete scheme of simulation has been developed using MATLAB/SIMULINK software which has wide range of utilization in engineering and science. The results so evaluated was found to be good for two different modes in DAB. The first technique is the mode 4 with either additive white Gaussian noise or Rayleigh channel. Similary the second technique is the mode 3 which offers more suitability of applications in Rician fading channels over 12 dBs. Thus this paper emphasizes more on Mode 4 and Mode 3 for the purpose of applications.

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