SIMULATION AND EVALUATION OF OFDM BASED DIGITAL VIDEO BROADCASTING (DVB) OVER DIFFERENT WIRELESS COMMUNICATION CHANNELS

[1]B.O.Omijeh and S. D. O. Agoye
[1]Department of Electronic and Computer Engineering,
[2]Centre for Information and Telecommunication Engineering,
University of Port Harcourt, Choba, Rivers State, Nigeria

ABSTRACT

Digital video broadcasting (DVB) is the television digital system. It's however much more than a simple replacement for existing analogue television transmission, this system has many advantages such as picture quality and allows you a range of new features and services including subtitling, multiple audio tracks, interactive content and multimedia content. The main purpose of this paper is to develop and simulate a DVB system using the Matlab software – the language of Technical Computing.
The system is based on the Quadrature Amplitude Modulation (QAM) and orthogonal Frequency Division Multiplexing (OFDM) technology, which allows DVB system to exploit the spectrum frequencies in a better way, saving spectrum.
This paper analyses the construction of DVB-T system model using Simulink with the purpose of investigating the bit error rate (BER) performance analysis of the OFDM based DVB-T 2k mode using different modulation schemes in different transmission channels.
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I. INTRODUCTION

Digital Video Broadcasting (DVB) system has become one of the most interesting developments in the area of consumer electronics at the end of the 20th century [1]. It's however much more than a simple replacement for existing analogue transmission, this system has many advantages such as better picture quality and allows a range of new features which includes subtitles, multiple audio tracks, interactive contents and multimedia contents. The principal like channel coding and equalization are implemented. But the equalization and different coding schemes introduces delays in the system and the cost of hardware is also very high so it is not feasible to the system as high data rate and the required reliability is very high.

The simulation has been developed in Simulink and Matlab. The Simulink is a platform for multi-domain simulation and model-based design of dynamic systems. It provides an interactive graphical environment and a customizable set of block libraries that let us accurately design, simulate, implement and test control, signal processing, communications and other time varying systems. Add-on products extend the Simulink environment with tools for specific modeling and design tasks and for code generation, algorithm implementation, test and verificationSimulink is integrated with MATLAB, providing immediate access to an extensive range of tools for algorithm development, data visualization, data analysis and access and numerical computation.

II.RELATED WORKS

Yun Hee Kim, Iickho Song, Hong Gil Kim, TaejooChang, HyungMyung Kim, Performance analysis of a coded OFDM system in time varying multipath Rayleigh fading channels," *IEEE Tran. Vehicular Technology*, vol. 48, September 1999

Steendam. H, Moeneclaey. M, "Analysis and optimization of the performance of OFDM on frequency-selective time-selective fading channels," purpose of this work is to simulate the basic system of Digital Video Broadcasting Terrestrial (DVB-T). This system is based on the Quadrature Amplitude Modulation (QAM) and Orthogonal Frequency Division Multiplexing (OFDM) Modulation.[2]

The radiated signal power and spectrum utilization are the two important communication resources for the design of any communication system. Because of the low radiated power and efficient utilization of the spectrum DVB-T systems are the popular standards. But the measure problem that the wireless communication suffers is the multipath propagation delay, fading and Inter Symbol Interference (ISI) due tothe frequency selectivity of the channel at the receiver side as a result of which the poor performance and high probability of errors degrades the efficiency of the system. So to overcome these limitations some advance techniques

IEEE Tran. Commun., vol. 47, pp. 1811-1819, December 1999.

III.Methodology

In this work, the performance evaluation of OFDM is done by sending the DVB-T based OFDM signal through AWGN, Rician and Rayleigh channel.[3] DVB-T 2k mode is analyzed over different values of SNR by changing different modulation schemes (4 QAM, 16 QAM and 64QAM), and BER is evaluated for the performance of OFDM signal for the mentioned channels and a conclusion is drawn based on the analysis.[4]

III Design Simulation Model.

This gives information about the Simulation model and the channel used in the simulation. Certain design parameters were modified in the model in Matlab/Simulink environment to achieve this work.

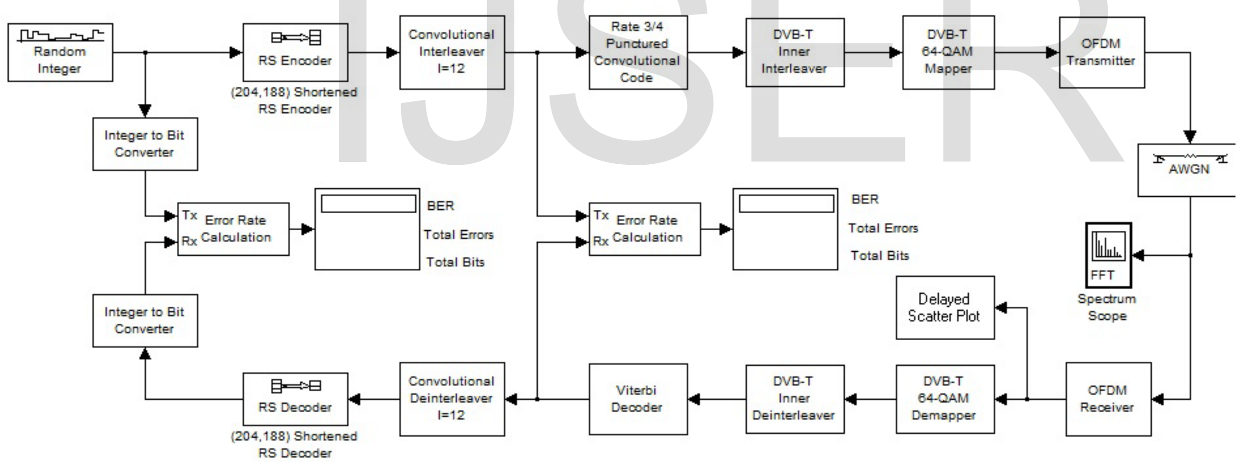

Figure1: Block diagram of the DVB-T transmitter.

IV. SIMULATION RESULTS AND DISCUSSION

The simulations performed are intended for the 8 QAM, 16QAM, 32QAM and 64QAM schemes where the SNR is varied in between 0 to 16 dB and the signal is analyzed at three channels which are AWGN, Rician and Rayleigh. In each of the figures below, the comparison between the three channels in question are shown. It is evident from the figure 3a, which is representing received constellation of 8QAM signal that the most affected path in terms of noise is Rayleigh channel as

constellation points. In comparison with figure 3b it is observed that the transmitted symbol is not received correctly due to large distance between the points representing the symbol. The modulation scheme used in this scenario is 16 QAM, so the number of bits representing one symbol will be 4. While from figure 3c, it is observed that the worst affected received signal appears in Rayleigh channel where it is difficult to even differentiate between the constellation points and such type of effects usually ends up in making a wrong

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the received constellation points are at a large distanceas compare toAWGN and Ricianreceived decision by the receiver.

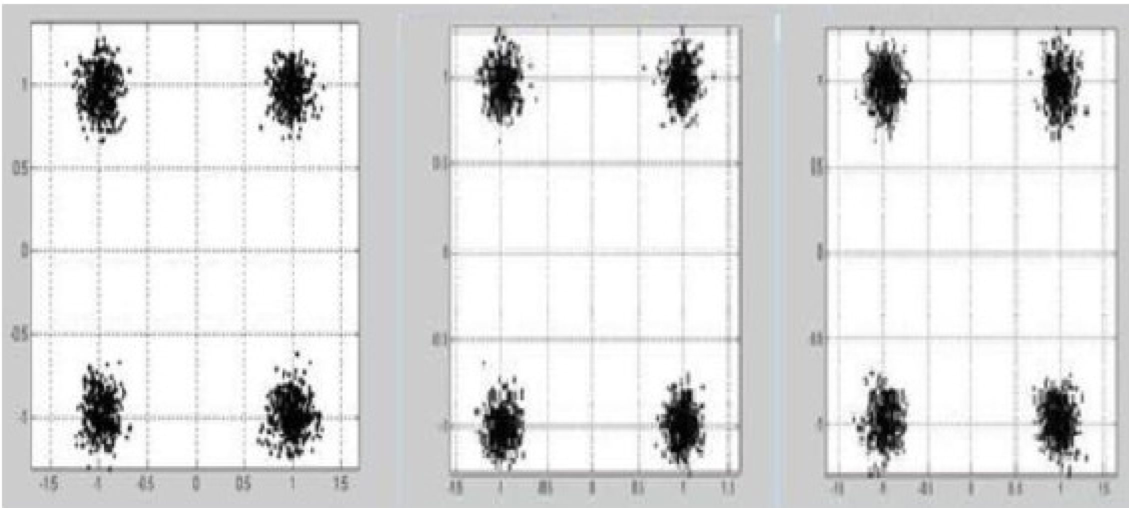

Figure 2a: QAM Received constellation of 8QAM Signal at 6dB SNR via AWGN, Rician and Rayleigh channel, respectively.

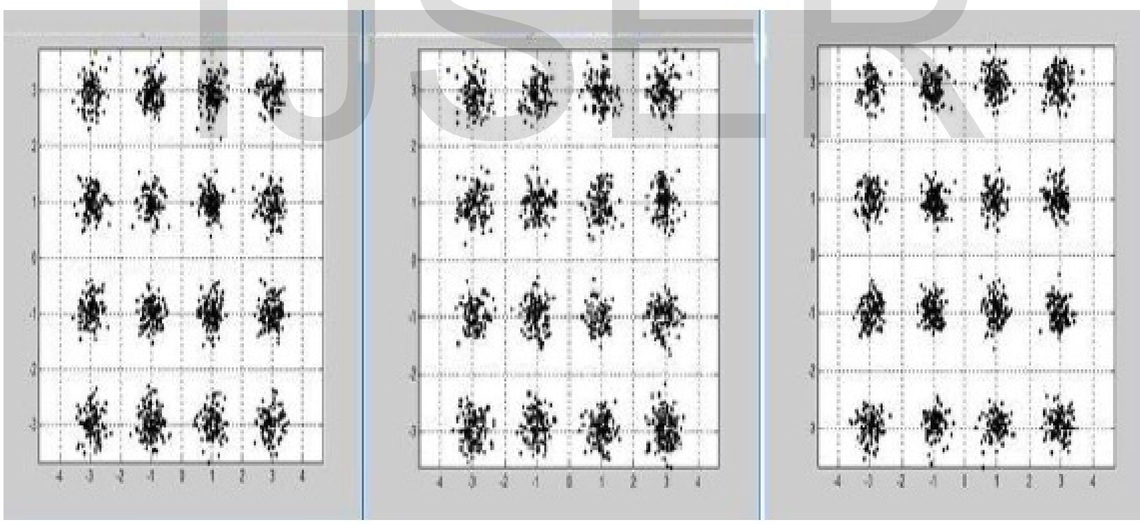

Figure 2b: QAM Received constellation of 16QAM Signal at 6dB SNR via Rayleigh AWGN, and Rician channel, respectively.

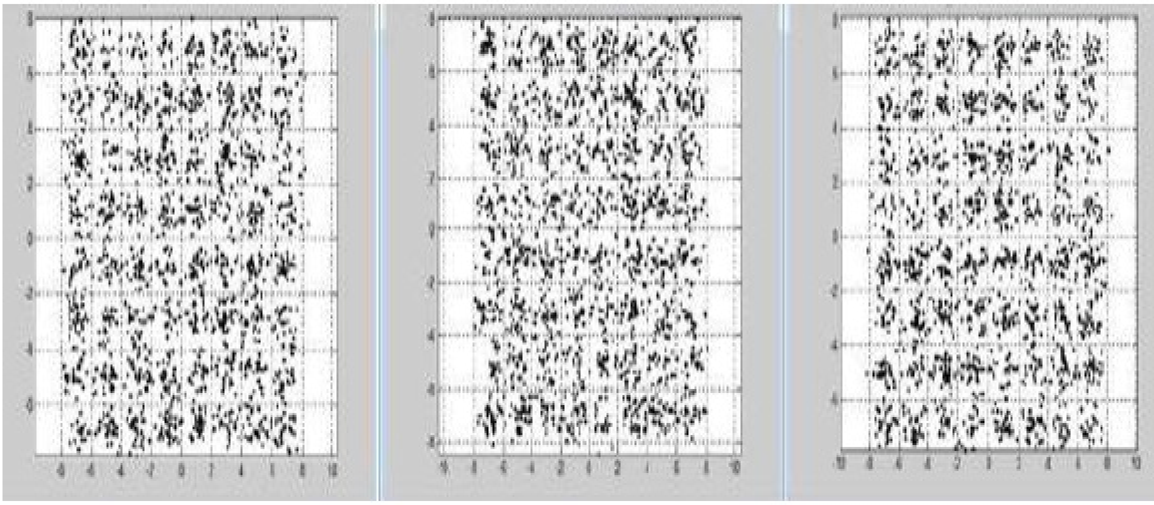

Figure 2c: QAM Received constellation of 64QAM Signal at 6dB SNR via Rayleigh AWGN, and Rician channel, respectively

Table 1: 8 QAM BER for AWGN, Rayleigh and Rician Channels

E_b/N_o	BER in AWGN	BER in Rayleigh	Rician
-5 : 0	**0.1064**	**0.1033**	**0.121**
0 : 5	**0.0952**	**0.0944**	**0.0991**
5 : 10	**0.0578**	**0.0608**	**0.0401**
10 : 15	**0.0235**	**0.0275**	**0.001699**
15 : 20	**0.0078**	**0.01**	**1.8399E-07**
20 : 25	**0.0025**	**0.0025**	**1.4E-19**

Table 2: 16 QAM BER for AWGN . Rayleigh and Rician Channels

E_b/N_o	BERin AWGN	BER in Rayleigh	Rician
-5 : 0	0.1212	0.0946	0.0986
0 : 5	0.1102	0.101	0.1027
5 : 10	0.0787	0.0861	0.0855
10 : 15	0.0472	0.0587	0.0565
15 : 20	0.006899	0.0293	0.0259
20 : 25	2.2099E-07	0.0114	0.0092

Table 3: 32 QAM BER for AWGN . Rayleigh and Rician Channels

E_b/N_o	BER in AWGN	BER in Rayleigh	BER in Rician
-5 : 0	**0.0935**	**0.0905**	**0.1094**
0 : 5	**0.0948**	**0.0935**	**0.0991**
5 : 10	**0.0763**	**0.0769**	**0.0742**
10 : 15	**0.0431**	**0.046**	**0.025728**
15 : 20	**0.0168**	**0.02**	**0.000772**

Table 4: 64 QAM BER for AWGN . Rayleigh and Rician Channels

E_b/N_o	BER in AWGN	BER in Rayleigh	BER in Rician
-5 : 0	0.1054	0.1033	0.421
0 : 5	0.0952	0.0944	0.0991
5 : 10	0.0578	0.0508	0.0501
10 : 15	0.0245	0.0575	0.001699
15 : 20	0.0078	0.01	1.9399E-07
20 : 25	0.0025	0.0025	1.4E-19

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20 : 25	**0.0056**	**0.0072**	**2.63E-08**

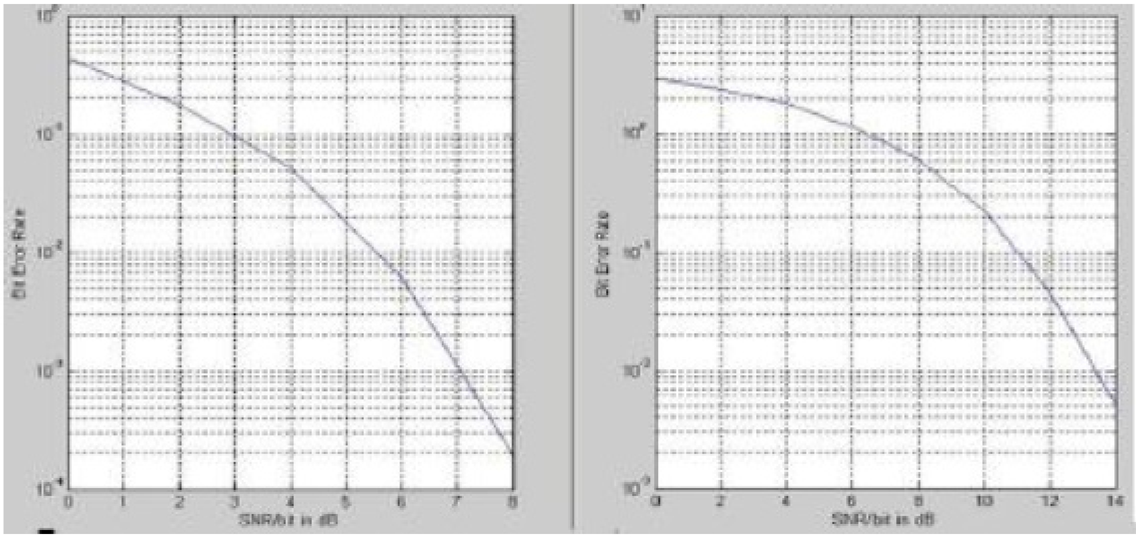

Figure 3a: Comparison between 8 QAM and 16 QAM BER for AWGN Channel

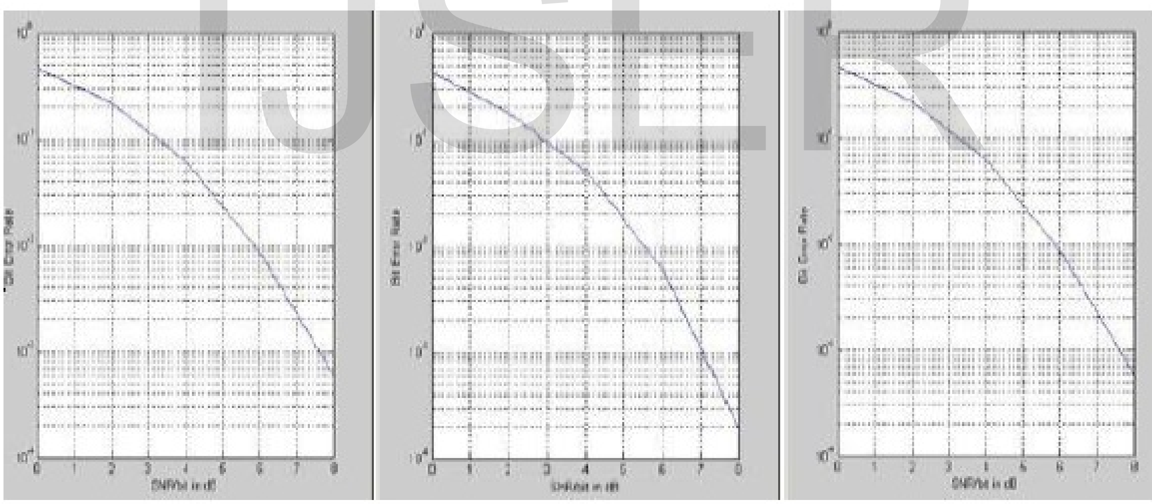

Figure 3b: BER of 8QAM Signal via AWGN, Rician and Rayleigh Channel at SNR 0 to 16 db

While utilizing 16QAM in 2K mode carrier, the BER graph shows that at an SNR of 0db the percentage of received bit in error Rayleigh channel[5] is almost 90 percent while there is 80percent chance that the received bits will be in error while in Rician channel this error percentage is reduced remarkably to 20 percent because of the reason that one or some of the wave are in strong line of sight. The percentages of error in received bits can be reduced by simply increasing the SNR value. Rician has proved to have the ability to tackle in fading environment as it is shown in figure 3f that for 16 QAM signal by increasing the value of SNR the error rate is decreasing. It can be observed in fig 3g by the calculation of BER that the Rician channel has the lowest BER as compare to Rayleigh and AWGN.

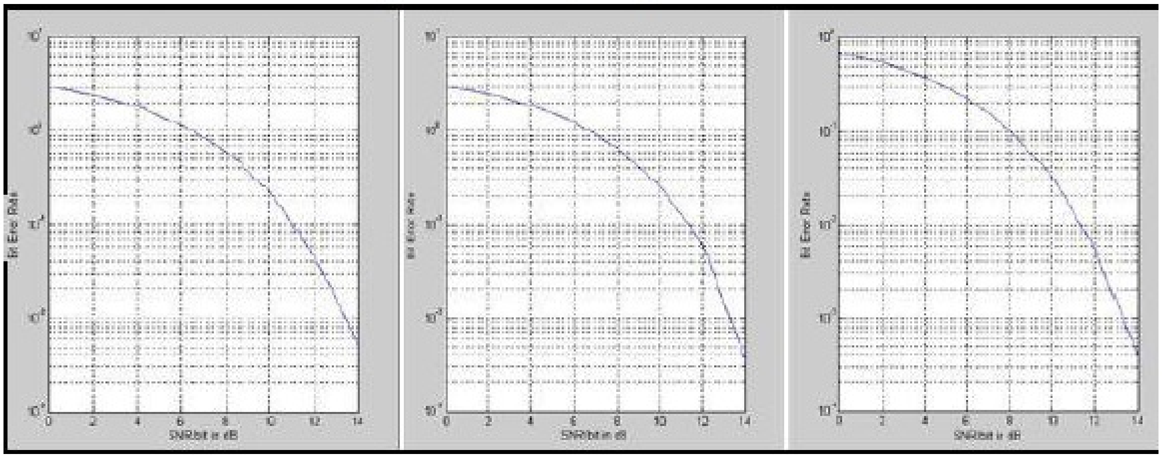

Fig. 3c: BER of 16 QAM Signal via AWGN, Rician and Rayleigh Channel @ SNR 0 to 16db

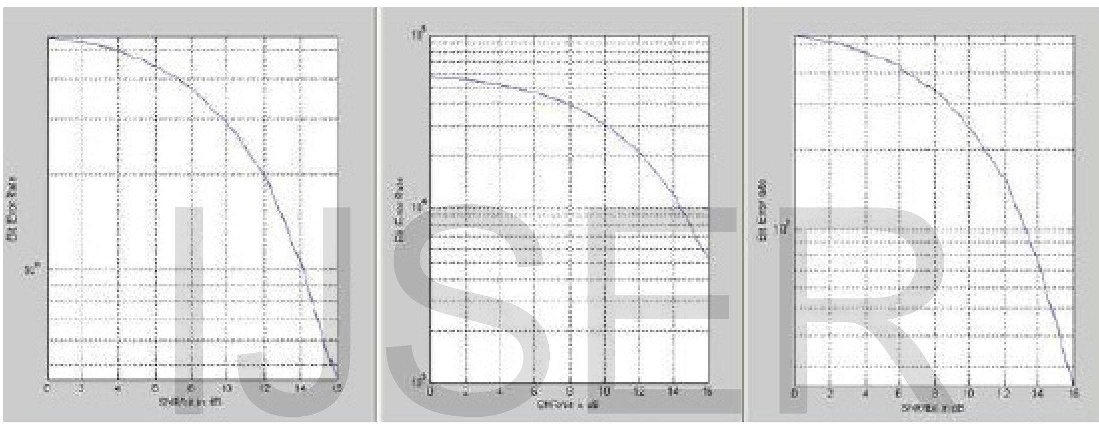

Figure 3d: BER of 64 QAM Signal via AWGN, Rician and Rayleigh @ SNR 0 to 16db.

This concludes that the schemes which have higher data rates are more prone to error than the schemes with lower data rates, the performance of different schemes can be made acceptable by increasing the SNR but only to a certain limited extent.[6] The performance of the Rician channel is remarkable and it is the least effected channel, so there must be a balance between the SNR and the modulation scheme that we are using for DVB-T based transmission so that the originally transmitted data can be recovered as it is quite evident from the graphs of the different schemes and channels that if we increase the data rate the bit error rate also increases even the SNR value failed to effect the reception at very high data rates like 64 QAM. So the effective modulation scheme found for the DVB-T is 16 QAM for 2k mode at the level of SNR 6db[7]

In a nutshell, it is not useful to apply higher modulation schemes without the error correction

VI. Performance evaluation of 2K Mode

The simulation presented above was targeted for DVB-T 2k mode where the performance of DVB-T was analyzed by using the parameters given by ETSI standard,[8] According to simulation it is found that 2k modes are less prone to errors but as the modulation scheme is increased, it starts to effect the performance of system by introducing more errors due to the fact that higher modulation schemes have higher ratio of errors which actually comply with the theory of the OFDM studies. For 2k mode video broadcasting, the scheme which was found reliable and robust was 16 QAM over the SNR of 6db. However it should be taken into account that the performance evaluated here does not included any error protection scheme or synchronization process.

Depending upon the simulation results which were obtained, it verified that the Rayleigh channel is the schemes, DVB-T has certain error correction method which when mixed with the higher modulation scheme can only be useful in that circumstances, which is for 2k it can support up to 64 QAM modulation scheme as long as the proper error correction coding is implemented[9]

Finally it is concluded that the schemes which have higher data rates are more prone to error than the schemes with lower data rates, the performance of different schemes can be made acceptable by increasing the SNR but only to a certain limited extent. If we increase the data rate the bit error rate also increases even the SNR value failed to effect the reception at very high data rates like 64 QAM. So the effective modulation scheme found for the DVB-T is 16 QAM for 2k mode[10][11].

V. CONCLUSION

For high data rate communication systems with high data capacity, high spectral efficiency, and resilience to interference and multipath effects, OFDM is ideal for the high data applications. In this project, a comparison of the performance of OFDM for Terrestrial Digital Video Broadcasting Systems for different QAM schemes was analyzed and the effect of different multipath channels, namely Rayleigh, Rician and AWGN.

The results which were obtained verify that Rayleigh is the least suitable and most affected multipath environment due to its non- line of sight communication and delay characteristics, whereas Rician shows the most promising result, while the AWGN performance lies in between these two.

Through the different modulation schemes that were also applied for the DVB-T based OFDM transmission and reception and it was found that as the modulation scheme increases from 8 QAM to 64 QAM, the chances for error (for example ISI) also increases because of the reason that high data rates has high probabilities of error due to less symbol period. The simulation results infer that the suitable modulation scheme for 2k mode is 16 QAM, at an SNR of 6 dB.

Due to the use of Fast Fourier Transform techniques to implement modulation and demodulation functions it is computationally efficient. The M-QAM modulation scheme is bandwidth efficient schemes for video transmission but at the same time it is less power efficient as the constellation points are close in worst channel and most affected multipath environment due to its non-line of sight communication and delay characteristics.

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64-QAM.

To achieve low BER we need to transmit symbols with more power. But for low M-order modulation schemes like 4 QAM, 16QAM these are more power efficient schemes as compared with higher order modulation schemes but at the same time these are bandwidth less efficient than 64-QAM and 32-QAM, as less number of bits per symbol.