Journal of Advanced Research in Image Processing and Applications
Volume 2, Issue 1 - 2019, Pg. No. 1-5
Peer Reviewed Journal

Article

Analyzing Performance of WRAN over AWGN & Rician Channel using Convolution and BCH Codes

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How to cite this article:
Walke MR, Wadekar VR. Analyzing Performance of WRAN over AWGN & Rician Channel using Convolution and BCH Codes. *J Adv Res Image Proc Appl* 2019; 2(1): 1-5.

Date of Submission: 2019-12-19
Date of Acceptance: 2020-01-03

ABSTRACT

Use of advance wireless services in our routine life is increasing day by day, which creates constraints on the availability of free spectrum for our daily use. Thus it requires a resource which can efficiently utilize the available radio spectrum and manage the available resources to make maximum use of it. One of the suggested resource is IEEE 802.22 WRAN (Wireless Regional Area Network), WRAN works on cognitive radio technique and senses the free availability of channels in television broadcast spectrum without interfering in its regular functionality especially in rural areas where its usage is minimum. In this paper, the performance of WRAN along its physical layer by using Convolution Coding (CC) and BCH Code with QPSK, 16-QAM & 64-QAM modulation techniques are implemented and simulated. The performance is analyzed with with respect to BER (Bit Error Rate) Vs SNR (Signal to noise ratio) curves obtained using matlab simulation for AWGN and Rayleigh & Rician fading channels in the presence of OFDMA.

Keywords: AWGN (Additive White Gaussian Noise), Orthogonal Frequency Division Multiplexing Access (OFDMA), WRAN(Wireless regional Area Network), SNR (Signal to Noise Ratio), BER (Bit Error Rate), Bose-Choudhary-Hocquenghem (BCH) Code

Introduction

The increased use of wireless services like internet access, Bluetooth etc restricts the use of radio resources to its full capacity due to regulation & license process. Although there are other Broadband Wireless Access (BWA) technology, mainly IEEE 802.16 WMAN (Wi-max) & WLAN (Wi-Fi) but their operating range of communication are their main constraints. But, IEEE 802.22 WRAN is designed to provide the wireless broadband service with help of Cognitive Radio (CR) which senses the free availability of the TV frequency spectrum without interfering in their regular functioning, especially in rural area where available spectrum is not good. IEEE 802.22 supports the unlicensed operation with CR technology in UHF/VHF TV broadcast band from 54 MHz to 862 MHz.[1] For proper transmission and reception in rural areas where geographical conditions are not supportive, OFDM technique can be helpful in this condition. WRAN is fixed to multi point system as its Base Station (BS) serves multiple receiver station known as Consumer Premises Equipments (CPEs) having its connectivity in both Line-Of-Sight (LOS) and Non-Line-of-Sight (NLOS) conditions. The normal range of WRAN is upto 30 Kms, it may exceed upto 100Kms depending on propagation condition. The base station may support atmost 255 CPEs. The data rate for communication system is 1.5Mbps in downstream direction i.e. directing from Base Station to CPE and Upstream of 384Mbps i.e. from CPE to Base station.

Role of Physical Layer And Mac Layer

The working of physical layer depends on the OFDMA scheme in TDD (Time division OFDM is having benefits over multipath propagation and multipath fading and yields high spectral efficiency. The physical (PHY) layer must be adaptive for various conditions and flexible enough to dynamically adjust bandwidth, modulation and coding schemes duplex) mode, also.[6] The modulation schemes practiced in IEEE 802.22 WRAN are QPSK, 16-QAM and 64-QAM, which can be used in conjunction with different code rates if required. Thus physical (PHY) layer is responsible for data transmission in WRAN.

MAC layer provide its supports in cognitive radio technology. MAC layer is combination of two frames i.e. Frame & super frame.[6] Super frame may be formed by many frames. MAC layer helps in sensing the spectrum for its free availability. The bandwidth of television spectrum is 6 MHz and in some countries it is 7MHz or 8 MHz. MAC layer carry out two types of sensing first is In-band sensing used for transmission between BS and CPEs, Other type is Out-band sensing for sensing the remaining spectrum.

Fading and Multipath

Fading refers to the decline in the strength introduced within the transmitted signal when it travels over certain propagation media. Fading is often modeled as Random process, generally present in two forms one as multipath fading and other as shadow fading. Since informer fading, signal reaches at the receiver by more than one path getting deviated from each other with respect to attenuation, delay and phase shift[7], while latter is introduced due to shadowing from obstacles affecting the wave propagation. Wireless communication is preferred over wired systems in rural areas due to the drawbacks of wired system such as geographical area coverage is large enough for low population, transportation problems, installation hurdles which can be overcome.[7] In wireless system, Line-of-Sight (LOS) propagation is not always possible thus Non-Line-of-Sight (NLOS) is present leading to multipath propagation by earth's obstacles, geographical area and tropospheric reflections. Thus the signal travelling through this path may be added constructively or destructively at the receiver giving it's adverse effect in signal decoding. In this paper, the performance of WRAN system is analyzed over different fading models namely Rayleigh and Rician and AWGN channel.

Physical Layer Specification

- **PHY Transport:** IEEE 802.22 uses Orthogonal Frequency Division Multiplexing (OFDM) as transport mechanism. Orthogonal Frequency Division Multiple Access being usefull for communication.
- **Coding:** Convolution Code is Mandatory. Turbo, LDPC or Shortened Block Turbo Code are Optional. Different codes rate are used which starts from 1/2, 2/3, 3/4, 5/6.[8] Optional code can be used to enhance performance of the system.
- Fourteen modes for transmission are available, out of which twelve are dedicated to data.
- Pilot Pattern - Each OFDM / OFDMA symbol is divided into sub-channels of 28 sub-carriers of which 4 are pilots. Pilot symbols are inserted once every 7 sub-carriers. Pilots cycle through all 7 sub-carriers over 7 symbol Duration.[9]

Simulation Model

In this paper the physical (PHY) layer of the IEEE 802.22 WRAN is simulated in MATLAB. The Fig shows the simulation model. Mainly diagram is divided into three parts as the transmitter, channel, and the receiver. The description of each block is provided below:

1. Random data generation: Random binary data of 1's and 0's is generated to avoid redundancy of long sequence of 1's and 0's .
2. Coding: Convolution Code (CC) is mandatory and Bose-Chaudhary- Hacquecum Coding (BCH) is used since both are block codes.
3. Interleaver: Interleaver spread out the burst error across the data means it converts the burst error into random error in order to save most informative bits by getting corrupted.
4. Modulator: QPSK and 16-QAM and 64-QAM modulation are used for simulation.
5. Buffer: Buffer is used to stack data. 5 bursts are put together to make 1440 data subcarriers.
6. Subcarrier allocation: Pilot and guard subcarriers are inserted in this stage. They are used for synchronization and channel estimation purpose. A pilot is inserted on every seventh subcarrier. In order to ensure that every subcarrier has been used as pilot, the position of pilot is changed regularly. The pilot insertion pattern repeats in every 7 OFDM symbols and 7 subcarriers.
7. IFFT: Inverse Fast Fourier Transform converts the frequency domain data set into corresponding time domain. It also generates the samples of the waveform which satisfy the condition of orthogonality.
8. Cyclic Prefix copies the last part of a symbol and paste it to the beginning of a symbol. CP is used to combat ISI & ICI interference.
9. Channel: AWGN channel and RICIAN fading channel are used for Simulation purpose.
10. Receiver: The functional properties of receiver using Viterbi & BCH decoder will be complimentary to the transmitter in order to regenerate the actual data.

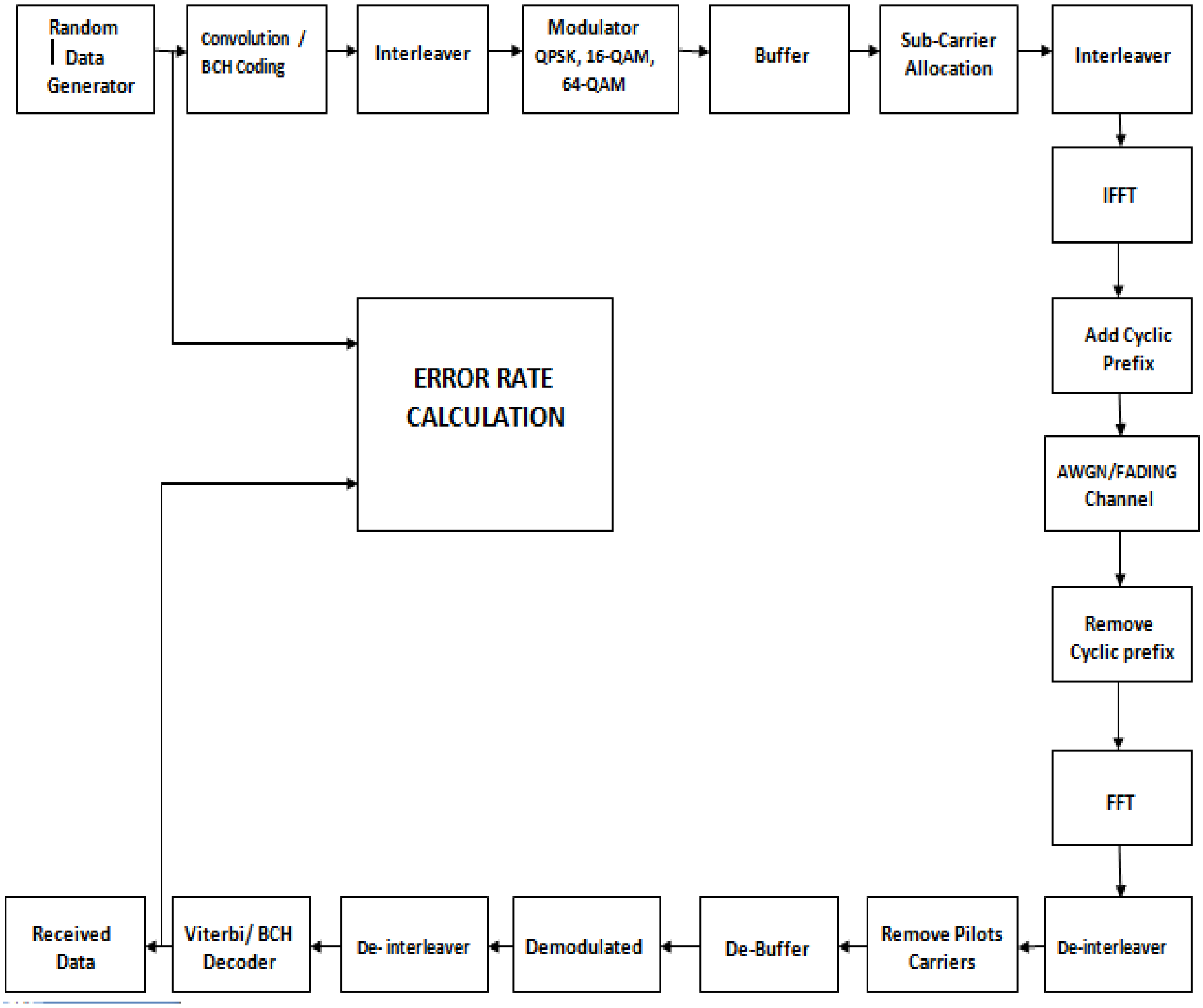

Figure 1.IEEE 802.22 WRAN PHY layer

Simulations and Result

In this paper performance of WRAN system is evaluated and compared using modulation methods as QPSK & 16 QAM and 64-QAM. The results obtained from the MATLAB Simulations are discussed in this paper. Since the fading phenomenon occurs as the signal moves from transmitter to receiver, MATLAB Provides a simple and easy way to demonstrate fading occurring in the wireless system.[7] Various BER (Bit Error Rate) Vs SNR (Signal to noise ratio) curves are obtained in the simulations which are shown with their respective parameters as follows:-

Awgn Channel

- Total No. of Subcarriers = 2048.
- Useful Subcarriers = 1440
- Pilot & Guard bits = 608 (240 pilots & 368 Guards)
- Cyclic Prefix = 1/4
- Channel coding = Convolution & BCH coding
- Channel = AWGN channel

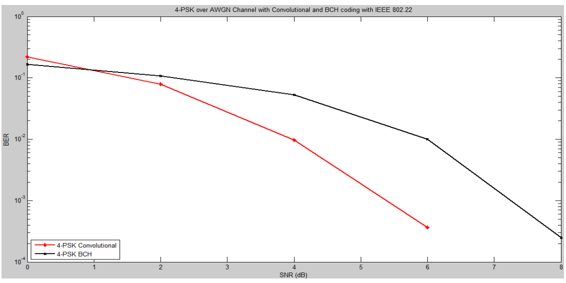

Figure 2.QPSK over AWGN channel with CC & BCH Coding

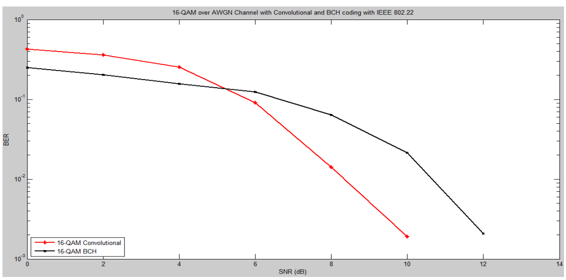

Figure 3.16-QAM over AWGN channel with CC & BCH Coding

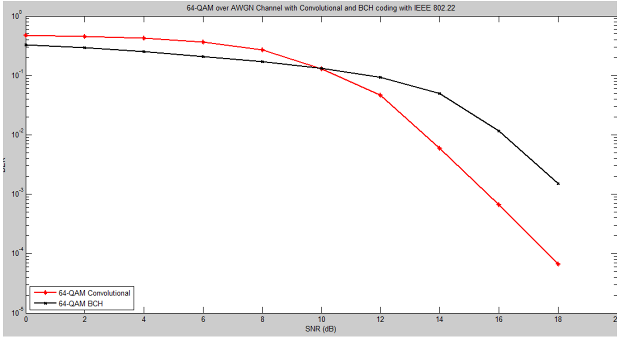

Figure 4.64-QAM over AWGN channel with CC & BCH Coding

Rician Fading Channel

- Total No. of Subcarriers = 2048.
- Useful Subcarriers =1440
- Pilot & Guard bits =608 (240pilot &368 Guard)
- Cyclic Prefix = 1/4
- Channel coding = Convolution & BCH coding
- Channel = Rician channel
- Sample Time = 1/(6.56e8)
- Max Doppler Shift = 100
- Delay Vector = 1/(6.56e6)* [0 1]
- Gain Vector = [10 -20]
- K Factor = 3

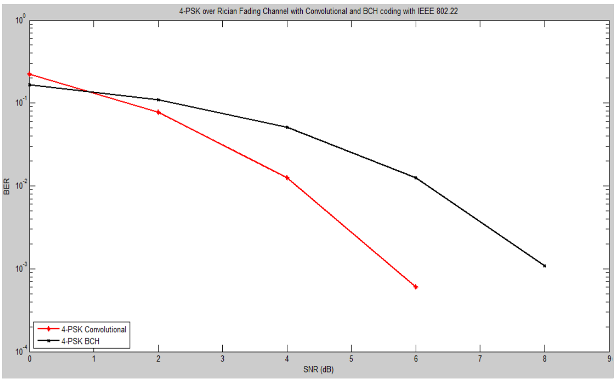

Figure 5.64-QAM over AWGN channel with CC & BCH Coding

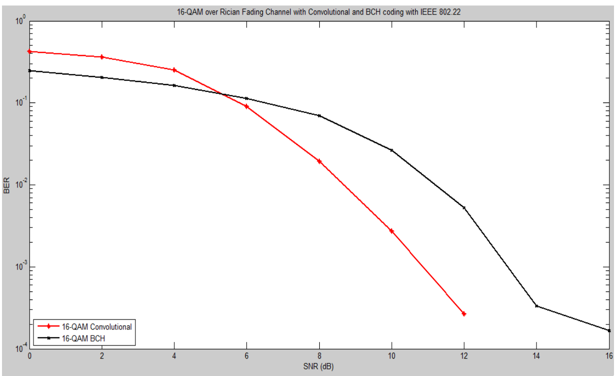

Figure 6.16-QAM over Rician Fading Channel with CC & BCH Coding

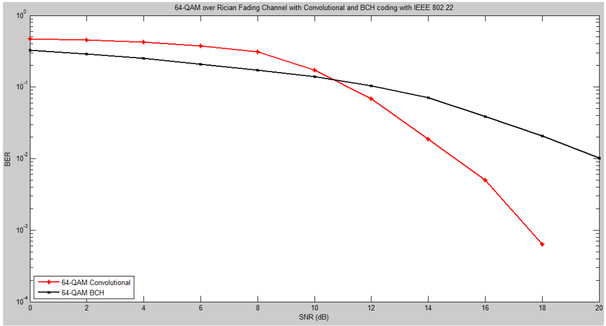

Figure 6.64-QAM over Rician Fading Channel with CC & BCH Coding

Table 1.Result for Convolutional Coding

S. No.	Channels	QPSK modulation	16-QAM modulation	64-QAM modulation
1.	AWGN	SNR = 6 dB BER = 3.6708e-04	SNR = 10dB BER = 0.0019	SNR = 18dB BER = 6.6742e-05
2.	RICIAN	SNR = 6dB BER = 6.0080e-04	SNR = 10dB BER = 0.0012	SNR = 18dB BER = 5.6742e-04

Table 2.Result for BCH Coding

S. No.	Channels	QPSK modulation	16-QAM modulation	64-QAM modulation
1.	AWGN	SNR= 8dB BER= 2.5008 e-04	SNR= 12dB BER= 0.0018	SNR= 18dB BER= 0.0023
2.	RICIAN	SNR= 8dB BER= 0.0010	SNR= 16dB BER= 1.6672e-04	SNR= 20dB BER= 0.0101

Conclusion

In this paper, MATLAB Simulation of physical (PHY) layer of IEEE 802.22 WRAN is provided. Comparatively analysis between Convolution & BCH Coding is done by using different modulation techniques in presence of OFDM. Thus results indicates that in AWGN & RICIAN channels, for higher SNR (dB) we are getting better BER (Bit Error rate) using Convolution coding and for lower SNR (dB) we get improved BER using other technique . Rayleigh coding doesn't produces better BER due to NLOS (Non-Line-of-sight) problem which can be countered by using MIMO technique.

References

1. Jain S, koshti R. Performance Improvement of IEEE 802.22 WRAN with Different FEC Codes. *International Conference on Machine Intelligence Research and Advancement, IEEE, computer Society*, 2013.
2. Haykin S. Cognitive radio: Brain empowered wireless communications. *IEEE J. sel. Areas Comm*.2005; 23(2): 201-220.
3. Mitola J. Cognitive Radios: Making Software Radios More personal. *IEEE Personal Communications*1999; 6(4).
4. Mitola J. Cognitive Radios: An integrated agent architecture for software defined radio. PhD Dissersation, Royal inst. Techno.(KTH), Stockholm, Sweden 2000.
5. Mehdi Ahmadi, Ehsan Rohani, Pooya Monshizadeh Naeeni, Sied Mehdi Fakhraie. Modeling and Performance Evaluation of IEEE 802.22 Physical Layer" 2nd International Conference on Future Computer and Communication IEEE 2010; 3.
6. Jain S, Upadhyay R. Performance Improvement of IEEE 802.22 WRAN Physical Layer. *IOSR Journal of Electronics and Communication Engineering* 2013; 6(2): 94-98.
7. Koshti R, Jangalwa M. Performance comparison of WRAN over AWGN & RICIAN channel using BPSK & QPSK Modulation with convolution coding. *International Conference on Communication Systems and Network Technologies, IEEE Computer society* 2013.
8. Shrivastava M, Bhati P. Performance Improvement of IEEE 802.22 With Different FEC techniques. *International Journal of Engineering Research and Applications (IJERA)* 2013; 3(4): 970-973.
9. Subramanium P, Rajeshree D. Raut. Improvement of BER on different fading channel using IEEE 802.22