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Performance Analysis of IEEE 802.22 WRAN over Rayleigh fading channel with & without convolution coding.

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Abstract: *The spectrum available for the wireless services is limited; the increased demand of wireless application has put a lot of constraints on the utilization of available radio spectrum. For the efficient spectrum utilization for wireless application IEEE 802.22 standard wireless regional area network (WRAN)) is developed, which is based on cognitive radio technique that senses the free available spectrum. In this work we are evaluating the performance of WRAN over physical layer by using QPSK modulation over Rayleigh fading channel and obtaining the bit error rate (BER) curves. Further we are reducing the BER for a lesser value of signal to noise ratio (SNR) so that the BER performance of the system is improved.*
Keywords: *WRAN, cognitive radio, Rayleigh channel. Convolution coding*

I. INTRODUCTION

IEEE802.22 WRAN is the first standard for wireless broadband access to support the unlicensed operation with cognitive radio (CR) technologies in the VHF/UHF broadcast bands from 54MHz to 862MHz. IEEE802.22 system is aimed at providing broadband access with packet-based transport capabilities that can support a wide range of services such as data, voice and video. On the basis of the Point-to-Multipoint (P-MP) topology, a base station communicates with at least one customer premise equipment (CPE) on the less populated rural areas. The typical range of the system is 33km for coverage of population density of about 1.25 person/km^2 and above, and up to a maximum of 100 km. The system will operate at the VHF/UHF broadcast bands and its radio environments may be possible in line-of-sight as well as non line- of-sight situations between a base station and fixed CPEs. With the regards of frequency reuse, the system should be deployable in both multiple and single cell environment. Basically, WRAN system has the similar aspects of WiMAX. The key difference is the service cell coverage and the coexistence with PUs which has the priority rights on the TV bands. IEEE 802.16 was developed to provide the infrastructure necessary to support both fixed and mobile wireless metropolitan access network in the range of 1-5 km radius. It operates on microwave frequencies above 2 GHz, e.g. WiMax at 2.5 GHz, 3.5 GHz and 2.3 GHz. IEEE 802.22 is intended for fixed wireless broadband services in rural areas covering a distance of up to 100 km.
In the next section we are emphasising on proposed simulation model of WRAN which is divided in transmitter, channel and receiver section.

1 PROPOSED SIMULATION MODEL OF WRAN.

1.1 TRANSMITTER OF WRAN.

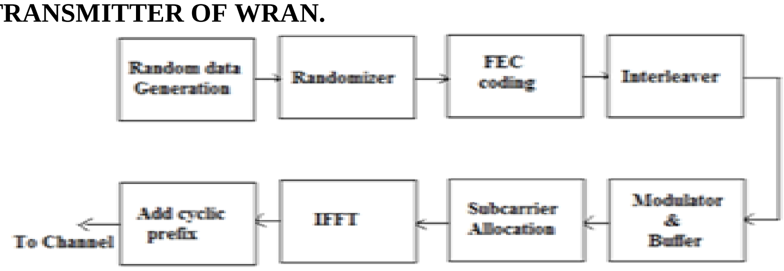

Fig1: Transmitter of WRAN

At the transmitter first binary random data is generated. Then by randomization the binary sequence is converted into to the random sequence to avoid long sequence of '0's & '1's. Here XOR operation is performed with 15-bit Linear Feedback Shift Register (LFSR). The generator polynomial defined for the randomizer is given by Equation -

$$1 + X14 + X15 \qquad (1)$$

With XOR gates in feedback configuration. Randomized data is then coded for forward error correction using Convolution Coding (CC). Interleaving is Similar to randomization but changes only the position of the bits not the state of the bits. The aim is to achieve desirable bit error distribution after demodulation. The incoming data into the interleaver is randomized in two permutations. First permutation ensures that adjacent bits are mapped onto nonadjacent subcarriers. The second permutation maps the adjacent coded bits onto less or more significant bits of constellation.Same permutation is done on the receiver side to rearrange the data bits into the correct sequence. Modulation is a fundamental process of a digital communication system. It involves mapping of data bits on to the subcarrier. The modulations scheme namely QPSK is adopted in this work. The output of the buffer depends on the number of symbols in one OFDM frame. The buffer puts several data bursts together, e.g. 5 burst, to prepare 1440 data subcarriers. The buffer is used to store the bits in stack form. After filling buffer the data it pushes the data into subcarrier allocation. In OFDMA subcarrier allocation scheme is used for multiuser OFDM system. Now pilots are inserted within the data subcarriers. Pilots are used for various estimation and synchronization purposes. Data subcarriers are again interleaved after the pilot subcarriers are inserted. The pilot subcarriers interleaving is similar to bit interleaving. We have 60X24=1440 data subcarriers to be interleaved.(60 sub channel X 24 data subcarrier / channel).Inverse Fast Fourier Transform(IFFT)converts the data from frequency domain to time domain data representing OFDM subcarrier. It generates samples of a waveform with frequency component satisfying orthogonality condition. By the addition of cyclic prefix Inter Symbol Interference (ISI) can be prevented. CP copies the last section of a symbol & pastes it to the beginning of symbol. It performs as a guard interval. The frame will contain total = L + N samples. Cyclic prefix parameter can be 1/4, 1/8, 1/16 or 1/32. In this work Rayleigh channel is taken into consideration for the analysis.

I.2 CHANNEL

When the signal is scatters between the transmitter and receiver then Rayleigh channel can be used. In this case the signal experiences a multipath fading phenomenon before arriving at the destination. In this form of scenario there is no single signal path that dominates and a statistical approach is required to the analysis of the overall nature of the radio communications channel.

Rayleigh fading channel itself can be modelled by[4] generating the real and imaginary parts of a complex number according to independent normal Gaussian variables. However, it is sometimes the case that it is simply the amplitude fluctuations that are of interest.There are two main approaches to this. In both cases, the aim is to produce a signal that has the Doppler power spectrum given above and the equivalent autocorrelation properties.

Let the scatterers be uniformly distributed around a circle at angles α_n with K rays emerging from each scatterer. The Doppler shift on ray n is $f_n = f_d \, Cos\alpha_n$ (2)

and, with M such scatterers, the Rayleigh fading of the Kth waveform over time can be modelled as:

$$R(t,k) = 2\sqrt{2\left[\sum_{n=1}^{M}(Cos\beta_n + j\,sin\beta_n)\cos(\omega n + \theta_{n.k}) + \frac{1}{\sqrt{2}}(cos\alpha + jsin\alpha)cos\omega dt\right]} \quad (3)$$

Here, α and the β_n and $\theta_{n.k}$ are model parameters with α usually set to zero, β_n chosen so that there is no cross-correlation between the real and imaginary parts of R(t)

$$\beta_n = \frac{\pi n}{M+1} \quad (4)$$

and $\theta_{n,k}$ used to generate multiple waveforms. If a single-path channel is being modelled, so that there is only one waveform then θ_n can be zero. If a multipath, frequency-selective channel is being modelled so that multiple waveforms are needed. The uncorrelated waveforms are given by:

$$\theta_{n,k} = \beta_n + \frac{2\pi(k-1)}{M+1} \quad (5)$$

This model is modified [10, 9] by choosing slightly different spacing's for the scatterers and scales their waveforms using Walsh-hadmard sequence to ensure zero cross-correlation. Setting

$\alpha_n = \frac{\pi\,(n-0.5)}{2\,M}$ and $\beta_n = \frac{\pi n}{M}$

This modified model is given by equation-

$$R(t.k) = \sqrt{\tfrac{2}{M}}\sum_{n=1}^{M} A_k(n)(\cos\beta_n + jSin\beta_n)cos(\omega nt + \theta_n)(6)$$

The weighting functions $A_k(n)$ are the Kth Walsh-Hadamard sequence in n. Since these have zero cross-correlation by design, this model results in uncorrelated waveforms **.**

I.3 RECEIVER OF WRAN.

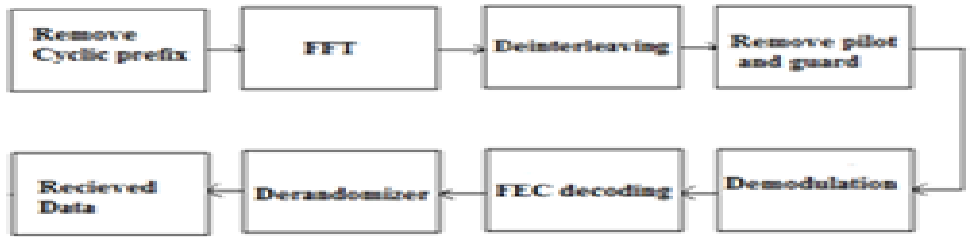

Fig 2: Receiver of WRAN

In the receiver section as shown in fig.2 first the cyclic prefix bits are removed. Since the total No. of subcarriers are 2048 and CP used for the simulation is 1/4 hence 512 bits of cyclic prefix are removed and then to convert the time domain signal in to frequency domain Fast Fourier Transform (FFT) is performed. After deinterleaving pilots and guard bits are removed and then demodulation, FEC decoding and derandomization process is executed.

II. CONVOLUTION CODING

Convolution codes represent one technique within the general class of channel codes. Channel codes (also called error-correction codes) permit reliable communication of an information sequence over a channel that adds noise, introduces bit errors, or otherwise distorts the transmitted signal.

Convolution coding is done by combining the fixed number of input bits. The input bits are stored in the fixed length shift register and they are combined with thehelp of mod-2 adders. This operation is equivalent to binary convolution and hence it is called convolution coding. The operation of convolution encoder is illustrated in following figure.

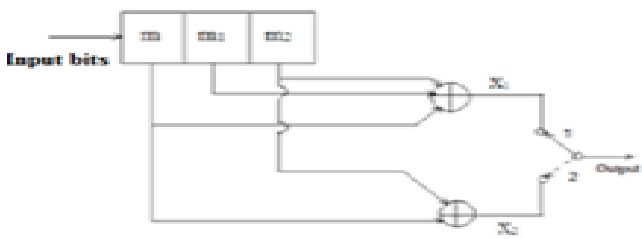

Fig 3: Convolution encoder with ½ code rate.

At each clock the content in the shift register is shifted by 1 to the right. The new input comes in as the first bit and the last bit will be the output. A shift register can be considered as adding some delay in the input. The shift registers can be understood as the "memory" of the encoder. It remembers the bits earlier in the sequence and performs operations with the following bits to output the final result. The shift registers are initialized as all 0's. Recall that Å is an XOR operator. 1Å1=0, 1Å0=1, 0Å0=0. If we work on an input sequence 010111001010001, the output is 00 11 10 00 01 10 01 11 11 10 00 10 11 00 112.

This encoder can also be modeled by a finite state machine. Each state is labeled by two bits --- the states of the two shift registers. Each transition is labeled w/v1v2, where w represents the input bit and v1 and v2 represent the two output bits. In this case, we always have w = v1.

TABLE 1: State of the output

	Next state/output Symbol, if	
Current State	Input = 0	Input = 1
00	00/00	10/11
01	00/11	10/00
10	01/10	11/01
11	01/01	11/10

III. SIMULATION PARAMETERS

IEEE 802.22 WRAN System is simulated over physical layer using Rayleigh channel in MATLAB 7.6. For the simulation random data is generated consisting of 10 Symbols. After converting Serial data into parallel form convolution coding is used as FEC code. Then Modulation is performed. Interleaving is used to convert burst error in to random error. After addition of pilot & CP bits Alamouti coding is implemented and signal is passed through the Rayleigh channel. Reverse process is performed at the receiver. The Simulation curves are obtained between BER & SNR which are shown in subsequent graph. Simulation parameters are as follows.

TABLE 2: Simulation parameters

Parameter	**Value**
Total No. of Subcarriers	2048
Useful Subcarriers	1440
Guard & pilot bits	608
Cyclic prefix	1/ 4
Channel coding	Convolution coding
Fading channel	Rayleigh channel
Bandwidth	6, 7,8 MHz
FFT	2048 points
Code rate	1/2
Modulation Methods	QPSK
No. of Transmitters & Receivers	2 & 1,2 Respectively

IV. SIMULATION RESULTS

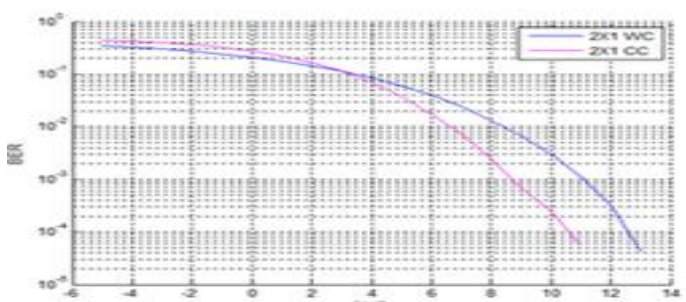

Fig 4: Comparison of QPSK-WRAN over Rayleigh channel with 2X1 without and With convolution coding.

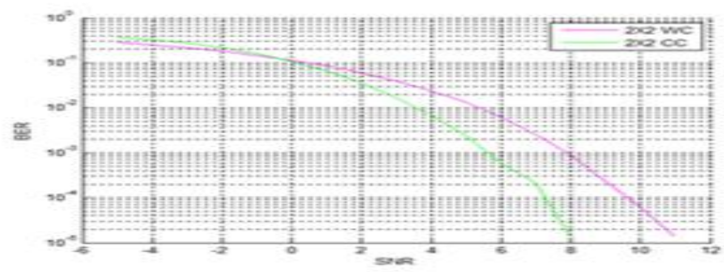

Fig 5: Comparison of QPSK-WRAN over Rayleigh channel with 2X2 without and With convolution coding.

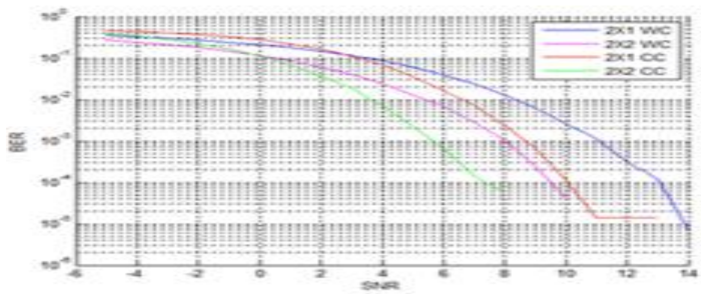

Fig 6: Comparison of QPSK-WRAN over Rayleigh Channel with 2X1 and 2X2 without and with convolution coding.

V. CONCLUSION

In this work WRAN is simulated at physical layer using MATLAB and from the results it is found that as the Number of receivers are increased SNR is reduced for a fixed value of BER however increasing the number of receivers is not cost effective hence it can be considered as limitation of this system and it gives scope for future work to fix up the BER for less number of receivers.

REFERENCES

Proceeding Papers:

[1]. K. Cordeiro, D. Challapali, D.Birru, and S.Shankar, "IEEE 802.22 : The First Worldwide Wireless Standard based on Cognitive Radios," Proc. IEEE Symp. New Frontiers in Dynamic Spectrum Access Networks (DySPAN 05), Nov. 2005, pp. 328-337, doi: 10.1109/DYSPAN.2005.1542649.

[2]. K. Cordeiro, D. Challapali, D.Birru, and S.Shankar, "IEEE 802.22 : The First Worldwide Wireless Standard based on Cognitive Radios," Proc. IEEE Symp. New Frontiers in Dynamic Spectrum Access Networks (DySPAN 05), Nov. 2005, pp. 328-337

[3]. S.H. Hwang, J.S> Um, M.S. Song, C.J. Kim, H.R. Park, and Y.H. Kim, "Design and Verification of IEEE 802.22 WRAN Physical Layer (Invited Paper)," Proc. International Conf. Cognitive Radio Oriented Wireless Networks and Communications (CrownCom 08), IEEE Press, May. 2008, pp. 1-6

Books:

[4]. W. C. Jakes, Editor (February 1, 1975). Microwave Mobile Communications. New York: John Wiley & Sons Inc.

[5]. U.dalal "Wireless Communication System", Oxford University press

IEEE Magzines & Technical reports:

[6]. C.Stevenson, G.Chouinard, L.Zhongding, H.Wendong, S.Shellhammer, and W.Caldwell, "IEEE 802.22: The First Cognitive Radio Wireless Regional Area Network Standard" IEEE Mag. Communications, vol. 47, Jan. 2009, pp.130-138, doi : 10.1109/MCOM.209.4752688

[7]. Channel management in IEEE 802.22 WRAN systems Published in IEEE Communication Magazine Volume 48 issue 9 88-94 on Sept.2010

[8]. I.F. Akyildiz, Y. Li, OCRA: OFDM-based cognitive radio networks, Broadband and Wireless Networking Laboratory Technical Report, March 2006.

[9]. P. Dent, G. E. Bottomley and T. Croft (24 June 1993). "Jakes Fading Model Revisited". *Electronics Letters* **29** (13): 1162–1163.

Thesis:

[10]. Eckardstein, S. and Isaksson, K. (December 1991). Kanalmodeller för radio transmission (Channel models for radio transmission) (Master's thesis) (in Swedish). Stockholm, Sweden: Royal Institute of Technology.