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BER PERFORMANCE IMPROVEMENT OF IEEE802.22 (WRAN) OVER AWGN CHANNEL USING MIMO TECHNOLGY

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ABSTRACT

The WRAN technology is useful for remote access to grid computer sites and to independent operating in developing countries ruler or non-metropolitan areas. WRAN specification are define by the IEEE 802.22 working committee. In this paper an overview of the standard and more specifically its physical layer is introduced. In order to evaluated the performance of the system. We model of the physical layer in MATLAB/SIMULINK.

KEYWORDS: WRAN, MIMO, STBC, QAM, BPSK, QPSK, Communicational cahannel, etc.

INTRODUCTION

Recent advance in the cognitive radio technology enabled the development of the new wireless system that can use the radio spectrum more efficiently. The particular the standard IEEE 802.22 wireless regional area network (WRAN) standard is begin currently developed to specifically address the ruler wireless broadband market. The IEEE 802.22 WRAN will operate in the TV spectrum band as secondary users below regulatory rules to avoid interference with the primary users that is TV broadcasting service. In the US the FCC has been developing the rules for the unlicensed secondary operation in the TV band. The IEEE 802.22 standard provided a new alternative to wireless solution for broadband access in rural and market community [1].

Spectrum sensing algorithms proposed for cognitive radio are well summarized in [2]. The simplest sensing algorithm is an energy detector but it is well known for its sensing degradation in performance under noise uncertainty. As points out in, robustness is a crucial performance metric for a spectrum detector. A robust blind sensing method called covariance absolute value detector is proposed in, which exploits the uncorrelated nature of noise and correlated nature signal. But the detection performance of CAV is comparable to an energy detector. A recent paper proposed two FFT based pilot detection method, one sensing the pilot energy and the other sensing the pilot location. Pilot location is robust to the noise uncertainty while energy detection is not. Under a certain noise power r, they both showed good performance. The propose a novel spectral covariance sensing (SCS) algorithm that exploits different statistical correlation of the signal and noise in the frequency domain. The SCS detects spectral features that allow sensitivity, but also robustness against uncertain noise power.

In this paper, we review the IEEE 802.22, its requirements and applications. Also discuss the main design challenges and new features of the upcoming IEEE 802.22 standard wireless that will address the wireless broadband standard problem in rural communities and emerging markets. In particular, we discuss the new cognitive radio features such as spectrum sensing (SS) and frequency agility that allows for efficient and reliable sharing of the TV band spectrum with primary users.WRAN is fixed point to multi-point (PMP) system and its connectivity between the base station and the Consumer premise Equipments is possible in both line-of-sight (LOS) and non-line-of-sight situations. In the standard typical support range is 30 km. meeting the demands of rural areas, but based on propagation conditions it may cover up to 100 km (kilometre). The minimum data rate of the system is 1.5 Mb/s in the downstream (DS) direction. from base station (BS) to Consumer premise Equipments (CPE) and 384 kb/s in the upstream (US) direction, i.e. from CPE to BS. It is expected that a BS supports up to 255 CPEs. A OFDMA is also a candidate access method for the IEEE 802.22 wireless regional area network.

THE IEEE 802.22 SYSTEM

While the major push (not only technical, but specially, regular) toward the commercial development of CRs is coming mostly from the US, the goal of IEEE 802.22 is to define an international standard that may operate in any regulatory regime. Therefore the current IEEE 802.22 standard project identifies the North American frequency range of operation from 54-862 MHz, while there is an ongoing debate to extend the operative range to 41-910MHz as to meet additional and international regulatory requirements [3].

Topology, Entities and Relationship

The IEEE 802.22 system specifies a fixed point- to-multipoint (P-MP) wireless air interface where by a base station (BS) manages its own cell and all associated consumer premise Equipments (CPEs), as depicted in figure 1[4]. The BS controls the medium access in its cell and transmits in the downstream direction to the various Consumer premise Equipments, which respond back to the base station in the upstream direction. In order to ensure the protection of incumbent services the IEEE 802.22 system follows a strict masters/slave relationship, where in the BS performs the role of the %master and the Consumer premise Equipments are the slaves. No Consumer premise Equipments (CPE) is allowed to transmit before receiving proper authorization from a BS, which also controls all the RF characteristics used by the CPEs.

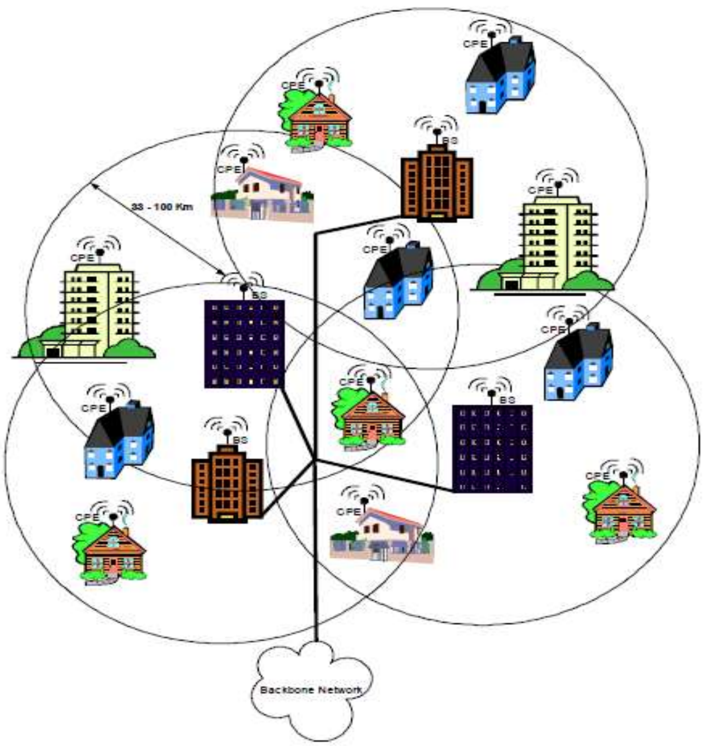

Fig 1. Exemplary 802.22 deployment configuration

Service capacity

The IEEE 802.22 system specifies spectral efficiencies in the range of 0.5 bit/(sec/Hz). If we consider an average of 3 bits/sec/Hz, this would correspond to a total PHY data rate of 18 Mbps in a 6 MHz TV channel.

Service coverage

A distinctive feature of IEEE 802.22 WRAN as compared to existing IEEE 802.22 standards is the BS coverage range, which can go up to 100 Km if power is not an issue. As shown in figure 2, A wireless RANs have a much larger coverage range than today’s networks, which is primarily due to its higher power and the favourable propagation characteristics of TV frequency bands technique. This enhanced coverage range offers unique technical challenges as well as opportunities.

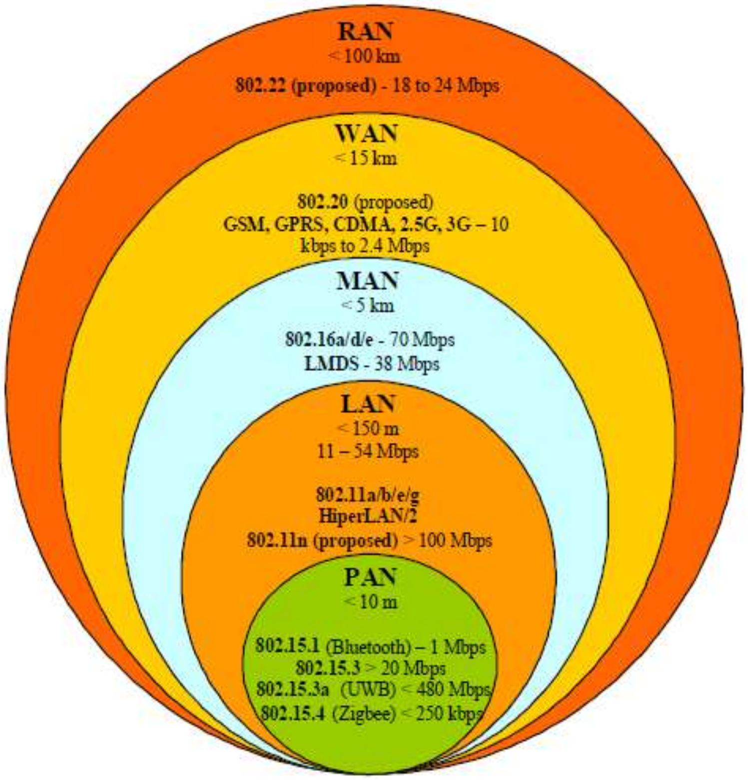

Fig 2. 802.22 wireless RAN classification as compared to other popular wireless standards

OVERVIEW OF THE IEEE 802.22 STANDARD

The IEEE 802.22 WRAN standard define PHY and MAC layer specifications for operation in the TV frequency bands in the range among 54 MHz, While avoiding harmful interference to incumbents. Standard is currently under development, and its draft includes new cognitive radio features which are discussed in the rest of this section [1].

Application.

The main goal of the IEEE 802.22 standard is to provide a cost effective wireless alternative to wired broadband access, and especially in sparsely populated areas. The IEEE 802.22 WRAN is a point to multipoint system where the Base Station provides connectivity to static Consumer Premise Equipments (CPEs) with its coverage area (cell).

The IEEE 802.22 PHY

The IEEE 802.22 PHY will support typical data rates of 1.5Mbit/s in the downstream (DS) direction and 384 Kbit/s in the upstream (US). According to the IEEE 802.22 draft, given .The adaptive modulation parameters and the operating constraints, and assuming. A 6 MHz TV channel bandwidth the system is expected to support up to 255 CPEs per BS per TV channel.

Spectrum sensing

In addition to the PHY modem, every CPE will also be equipped with a spectrum sensing system, which should meet the regulatory requirements for sensing (TABLE I). Although the particular algorithm used is implementation dependent, the IEEE 802.22 standard describes several sensing techniques with corresponding evaluation results (based on simulation) that can be algorithms discussed in the IEEE 802.22 draft [5] that achieved best performance result.

SPECTRUM SENSING

Sensing Requirement of WRAN system

The functional requirement document of the WRAN system defines the sensing threshold as table I. On the condition of table I, false alarm probability 10% and detection probability 90% must be achieved to meet the sensing requirement of the WRAN system [4].

Table 1. IEEE 802.22 WRAN sensing requirement

	ATSC	NTSC	PART 74
Sensing Requirement (dBm)	-116	-94	-107
Bandwidth (MHz)	6	6	0.2
SNR (dB)	-22.2	-0.2	1.5

Refer to the table II, the WRAN system has to sense signal level of -116dBm which is below the conventional noise level. To achieve the sensing requirement, the sensing process needs long period which leads reduction of data transmission period causes QoS (Quality of service) deterioration, effort to reduce required quite period is needed in sensing process.

Energy Detection Sensing

The energy detection is the simplest and generally used signal detection algorithm. Fig. 1 describes block diagram of the energy detection algorithm. It measures the received signal energy for unit time, and decides the signal presence whether the measured energy is greater than the threshold or not. The threshold is determined by the false alarm probabilityderived from the noise probability density function. The detection probability and the false alarm probability of the energy detection are defined respectively

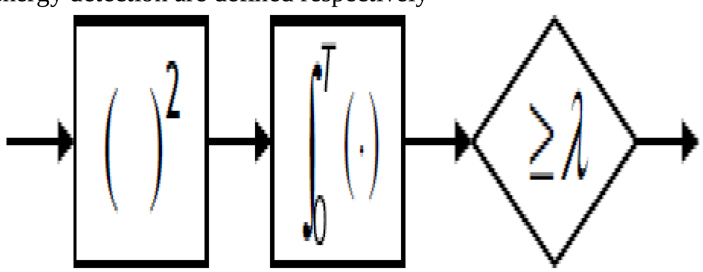

Fig 3 . Block diagram of energy detection

$$P_D = P_r\ \{Y > \ |H_1\} = Q_{N/2}\left(\sqrt{2\gamma},\sqrt{\lambda}\right), \qquad (1)$$

$$P_{FA} = P_r\,\{Y > \lambda\ |H_0\} = \frac{\Gamma\left(\frac{N}{2},\frac{\lambda}{2}\right)}{\Gamma\left(\frac{N}{2}\right)}, \qquad (2)$$

Where P_D is the detection probability, H_1 andH_0. In respectively represent the hypothesis that the signal is present or not, and Y is the received signal energy. Q_m $(.)$ Is the Marcum Q function, λ , is the detection threshold, N is the number of samples used for energy detection, and γ is the signal-to-noise ratio (SNR) P_{FA}defines the false alarm probability where $\Gamma(.)$ is the Gamma function. For the energy detection, the received signal power is unstable due to the channel effect such as fading, and the decision threshold also has an uncertainty because of biased noise power estimation in real environment. For this reason, the energy detection algorithm cannot achieve the sensing requirement. On the other hand, the other detection algorithms such as cyclostationary feature detection require huge complexity. As a substitute approach, data fusion method can be considered without increasing complexity of each nod.

MIMO SYSTEM MODEL

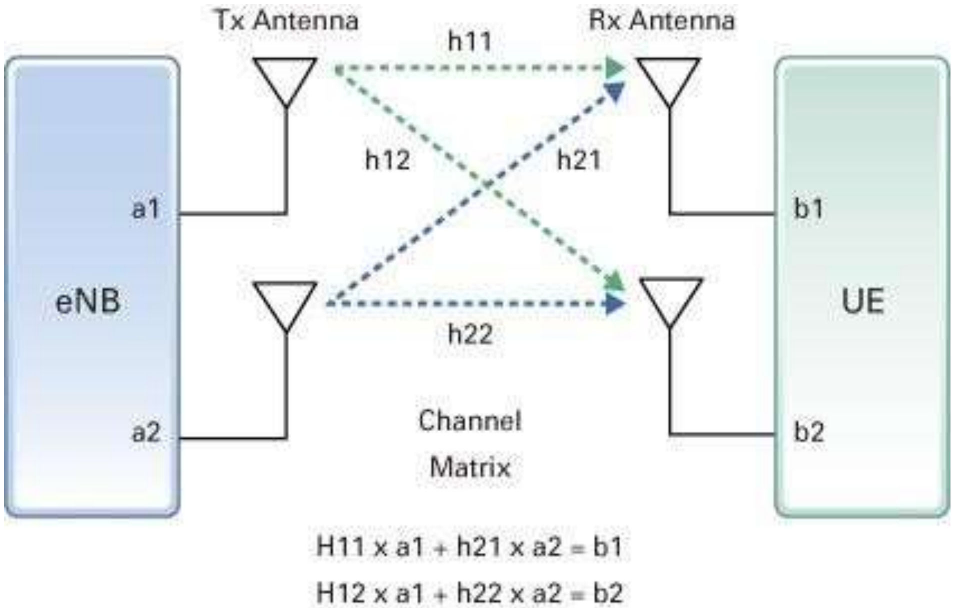

Fig 4. The MIMO Channel

The 2X2 MIMO channel is represented in Fig. 3 an antenna array with 2 elements at the transmitter and an antenna array with 2 elements at the receiver is considered. In the input-output notation of the MIMO schemes can now be The Zero-Forcing Equalizer applies the inverse of the communication channel to the received signal, to restore the signal before the channel. The name Zero Forcing corresponds to bringing down the ISI to zero in a noise free case. This will be useful when ISI is significant compared to noise.

$$y(t) = H(\tau,t)\otimes s(t) + u(t) \qquad (4)$$

where $\otimes$ denotes convolution, s(t) is a n_t X 1 vector corresponding to the n_t transmitted signals, y(t) is a n_r X 1 vector corresponding to the n_r and u(t) is the additive white noise.

The impulse response of the channel between the j^{th} transmitter element and the i^{th} receiver element is denoted as $h_{ij}(\tau,t)$. The MIMO channel can then be described by the $n_r X\ n_t\ H(\tau,t)$ matrix.

$$H(\tau,t) = \begin{bmatrix} h_{1,1}(\tau,t) & h_{1,2}(\tau,t) & \cdots & h_{1,n_t}(\tau,t) \\ h_{2,1}(\tau,t) & h_{2,2}(\tau,t) & \cdots & h_{2,n_t}(\tau,t) \\ \vdots & \vdots & & \vdots \\ h_{n_r,n_1}(\tau,t) & h_{n_r,n_2}(\tau,t) & & h_{n_r,n_t}(\tau,t) \end{bmatrix} \qquad (5)$$

The matrix elements are complex numbers that correspond to the attenuation and phase shift that the wireless communication channel introduces to the signal reaching the receiver with delay τ.

RESULTS AND DISCUSSION

IEEE 802.22 WRAN System is simulated over physical layer using Rayleigh channel in MATLAB 7.14. 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. In this section, BER (Bit Error Rate) analysis of MIMO system over AWGN channel using STBC code structure is done for M-PSK Modulation techniques

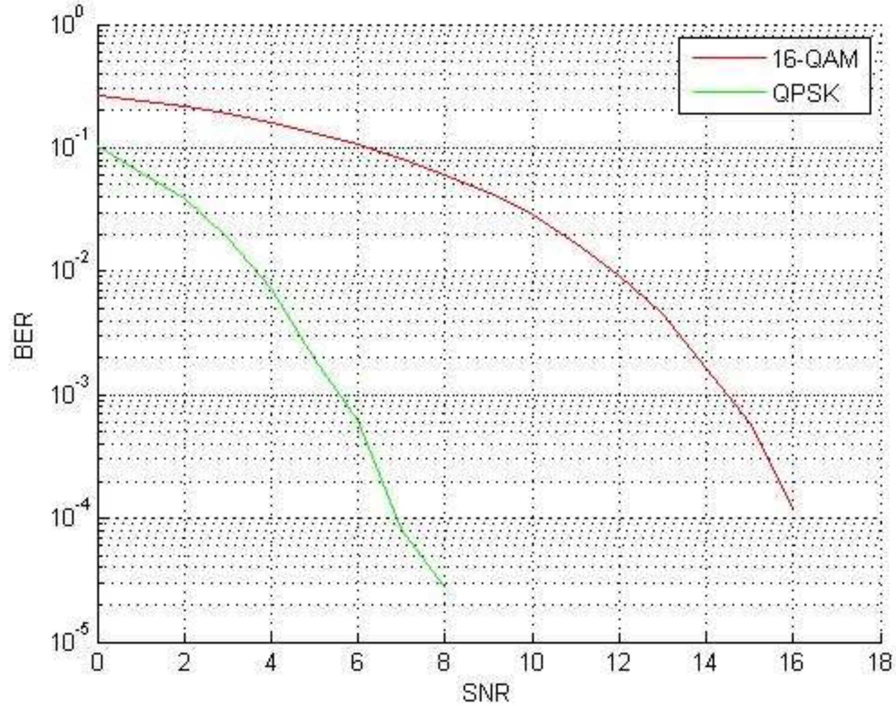

Fig 1. Comparison of QPSK AND 16-QAM over awgn with 3x1

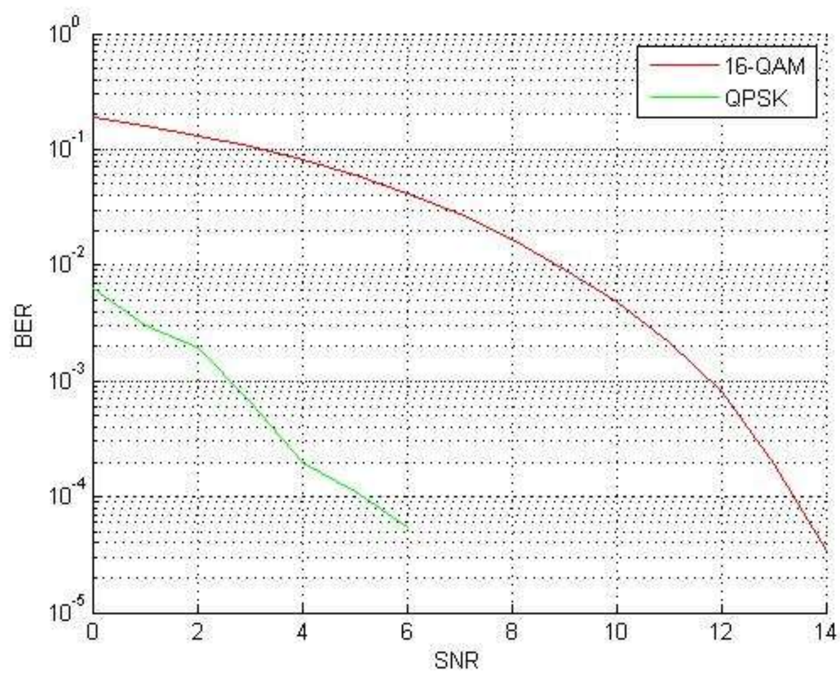

Fig 2. Comparison of QPSK AND 16-QAM over awgn with 3x2

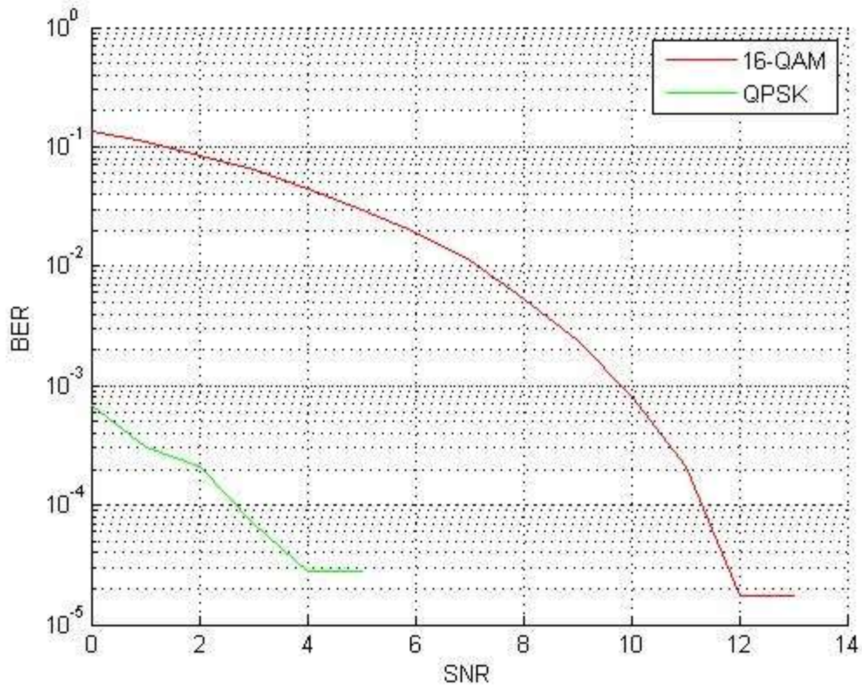

Fig 3. Comparison of QPSK AND16-QAM over awgn with 3x3

CONCLUSION

In this paper, the performance analysis of WRAN and MIMO system over AWGN fading channel employing different antenna configurations is presented. It can be depicted from the graphs that the BER keeps on decreasing in MIMO system due to space diversity as increasing the number of receiving antennas. The multiple receivers or multiple transmitters reduce multipath fading and enhance SNR. Thus the proposed system provides better BER performance.

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