

Performance Evaluation of IEEE 802.11b/n in Wireless Networks for QoS Improvement

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Abstract - The development of technology in the wireless communication domain has enhanced the need for power optimization schemes, because the battery technology has not kept up pace with the ever increasing growth of mobile devices. Power consumption can be reduced by decreasing the transmit power to a minimal optimum level, such that the packets are received correctly. This paper compares IEEE 802.11b and IEEE 802.11n wireless networks and shows that optimization of power control, increases the life of the battery and maybe achieved by the implementation of IEEE 802.11n. The paper studies the power consumption as against the transmit power and also shows the effect of co-channel interference. Elements of network performance include throughput, delay, bandwidth and channel utilization. The result compares IEEE802.11n with IEEE802.11b in terms of power consumption. The results show an improvement in performance of the wireless network using IEEE 802.11n.

Keywords: Wireless Networks, Power Optimization, QoS Improvement,802.11n, MAC

I. INTRODUCTION

Wireless communication is a ever increasing technology development. Wireless devices have become an integral part of everyday life. Ad-Hoc wireless networks are a type of network that does not require a fixed infrastructure and operate on multi-hop wireless links. Energy resource plays a vital role and the network requires mechanism to increase the lifetime of the nodes by implementing schemes that will result in adjusting the transmit power, controlling the battery discharge and scheduling of power sources. Adjustment of transmit power requires techniques that will help in finding the optimum power level for the nodes in a network.

Prior works have shown that optimizing the power levels of the nodes in a network will lead to power saving. Since the batteries have limited energy, reducing the energy consumption becomes important. Powers saving schemes serve as energy saving methods. Much research has been done on power control [1],[2],[3],[4],[5]. These studies show that incorporating power control schemes provides both the benefits of capacity improvement and reduced power consumption.

The IEEE802.11 is one of the most dominant Mac protocols in wireless networks. Many commercial wireless products are based on the IEEE 802.11 standard [6]. The standard provides wireless connectivity for portable or hand-held devices. Wireless connectivity is well established and finds wide spread application as a solution for usage in airports, hotels, cafes and offices. Devices such as microwave ovens, Bluetooth devices, baby monitors and cordless telephones operate in the 2.4 GHz range.

There are two access methods defined by the IEEE 802.11 standard [6]. They are the Distributed Coordination Function (DCF) and the Point Coordination Function (PCF). CSMA/CA technique is used by DCF and it allows for contended access to the wireless channel. PCF, on the other hand, provides uncontended access. A best effort type of service is provided by DCF, whereas a guaranteed reliable service is provided by PCF. Coexistence of both methods is also possible, with a contention period and a contention-free period. PCF is well suited for real-time traffic. In this paper, we limit our investigation to the DCF scheme.

The DCF provides access to the shared medium and has two techniques for the same: basic access scheme and RTS-CTS exchange. The DCF [6] uses of CSMA/CA (Carrier-Sense Multiple Access with Collision Avoidance) to allow the sharing of the medium among the compatible stations. This mechanism allows a station to transmit only if it has found that the medium has been idle for at least the duration of one

DIFS (Distributed Inter-Frame Space) time. A random back-off strategy is also employed to reduce the collision among the many stations trying to access the medium.

A major objective of this paper is to achieve energy efficient communication using IEEE 802.11b/n standards. Power control should be implemented in such a way that the minimum transmit power should be employed to reach the receiver. This has the beneficial effect of improving the capacity of the network. In this paper we compare 802.11b and IEEE 802.11n wireless networks in terms of power consumption. We discuss the performance of these standards using different channel models. We analyze the 802.11 b/n systems based on the energy consumption, to demonstrate the viability of chosen solutions. We assume power saving to be the primary objective, with throughput and delay becoming secondary objectives.

The rest of this paper is organized as follows. Section II briefly describes the background on IEEE 802.11 standards. Section III describes the channels for wireless networks. Section IV provides the simulation results. Finally, the performance evaluation of both IEEE 802.11b and IEEE 802.11n access schemes are carried out in Section IV. The concluding remarks are given in Section V.

II. SYSTEM OVERVIEW

A. IEEE 802.11 b/n specifications

The original IEEE 802.11 standard provided three initial specifications for the physical layer [7]. The standard provides an economical and flexible solution without the need for physical wiring.

Out of these, two specifications operated at 2.4GHz and the third was operating at the baseband.

TABLE I. SPECIFICATIONS OF MAJOR STANDARDS

Parameter	802.11b	802.11a	802.11g	802.11n
Operating Frequency	2.4 GHz	5 GHz	5 GHz	2.4 or 5 GHz
Max.data rate	11 Mbps	54 Mbps	54 Mbps	100 Mbps
Modulation	CCK or DSSS	OFDM	CCK, DSSS or OFDM	CCK, DSSS or OFDM
Number of spatial streams	1	1	1	1,2,3 or 4
Bandwidth (MHz)	20	20	20	20 or 40

Each of these standards has different features and were published at different times. They have different data throughput speeds and operate on different bands.

The IEEE 802.11a uses Orthogonal Frequency Division Multiplexing (OFDM), but had the major disadvantage of utilizing the 5GHz frequency band, providing data rates up to 54Mbps.

The IEEE ratified the 802.11b specification [1] and it operates in the 2.4 to 2.497 GHz bandwidth of the radio spectrum. It employs Complementary Direct Sequence Spread Spectrum with complementary code keying as the modulation technique and achieves up to 11 Mbps.

Of these, the IEEE 802.11b is a wireless standard that provides a good performance with data rates up to 11 Mbps and a good range. It is widely employed in what are called as hotspots for wireless communication. The 802.11 b uses the CSMA/CA technique for data transmission, as in the original base standard. The original 802.11 standard uses CDMA/DSSS whereas 802.11b uses Complementary Code Keying for the RF signal format.

IEEE 802.11n is a high speed standard, based on MIMO (multiple-input multiple-output) air interface technology. Wireless data communication standards that are not compatible with 802.11 employ MIMO. Spatial multiplexing is employed in MIMO, which increases the data rate. It provides very high data throughput rate from the original data rate 54 Mb/s to the data rate in excess of 600 Mb/s because the technique of the MIMO can increase the data rate by extending an OFDM-based system.

The 802.11n employs MIMO technology and channel bonding. It employs advanced coding techniques and achieves data rates up to 100Mbps. The MIMO technology is a technology which uses multipath propagation, in which a signal reaches the receiving node through multiple paths. Due to this, more than two data streams can be simultaneously transmitted in the same frequency channel. This in effect increases throughput. The major features in this standard are MIMO power saving, OFDM modulation scheme, wider channel bandwidth and increased throughput. The OFDM implementation results in increased data rates up to 65 Mbps.

In this paper, we evaluate the performance of the most popular 802.11b and the high data rate 802.11n standard.

III. CHANNEL DESCRIPTION

The success of the ever increasing deployment of wireless networks depends on whether the networks meet the required Quality of service specification. It becomes important to evaluate the performance of wireless devices, for which several models have been proposed.

IEEE 802.11 operates in the unlicensed 2.4GHz spectrum and the licensed 5GHz spectrum. Interference is a major issue in wireless networks. There are basically two categories of interference: co-channel interference and adjacent channel interference. Co-channel interference occurs due to transmissions in the same channel as the receiver, whereas adjacent channel interference is due to the transmission in the neighboring channels.

Therefore, it becomes essential to model wireless channels, which try to describe the wireless environment as close as possible. The collection of nodes, forming a wireless network may often not communicate using Line-of-Sight (LOS). There is another propagation phenomenon called multipath propagation, in which the transmitted signals reach the receiving end through two or more paths. These physical limits on the communication of the network affect the performance of the network. The need arises to use channel models that characterise such physical limits. These channel models provide an estimate of the physical-layer performance of wireless transmission.

In this paper, we consider two such popular channel models: the Additive White Gaussian Noise (AWGN) channel and the Rayleigh channel.

The AWGN is a basic channel model, which is Gaussian in nature. It does not take into account fading, frequency selectivity, nonlinearity or dispersion. It is one of the basic models, which is commonly used to simulate background noise of a channel. The signal being transmitted gets disturbed by an additive, white Gaussian noise.

Distributions such as Rayleigh, Rician, Nakagami, etc describe the statistically time varying nature of the envelope of a flat fading signal. Rayleigh fading channel is a useful model of real-world phenomena in wireless communications. These phenomena include multipath scattering effects, time dispersion, and Doppler shifts that arise from relative motion between the transmitter and receiver. When tropospheric and ionospheric propagation are to be considered, the Rayleigh fading can be used as a model.

IV. SIMULATION RESULTS

Simulations were done in Matlab with simulink. Simulations were performed to evaluate the performance of the IEEE 802.11 b and n standards in the Rayleigh channel and AWGN channel. The results show the effects of various communication channel parameters on the throughput for in the different frequency bands.

Common simulation parameters were considered such as a MIMO-OFDM transceiver with a 64-point FFT/IFFT and a constant SNR array with six multi paths on AWGN and Rayleigh channel. A constant Bit Rate traffic source was considered, in which 1000 packets are transmitted in 16 duty cycles. Under these consideration throughput was calculated using the SNR and BER Combination.

The first simulation was run using the 2.4 GHZ signal frequency. The noise power in the AWGN channel was fixed at 1mW watts per symbol while the data rate was varied between 64, 128 and 250 Kbps.

TABLE II. PERFORMANCE IN AWGN AND RAYLEIGH CHANNEL FOR AN AVERAGE THROUGHPUT OF 10Mbps.

TABLE III.

<i>Channel</i>	<i>802.11b</i>	<i>802.11n</i>
AWGN	0.01mW	1mW
Rayleigh	0.01mW	50 mW

The figure shows the plot of the throughput achieved and the power consumed while employing IEEE 802.11 b and n standards in the AWGN channel. The power consumed for an average throughput of 10 Mbps was 1mW for IEEE 802.11b and 0.01mW for IEEE 802.11n.

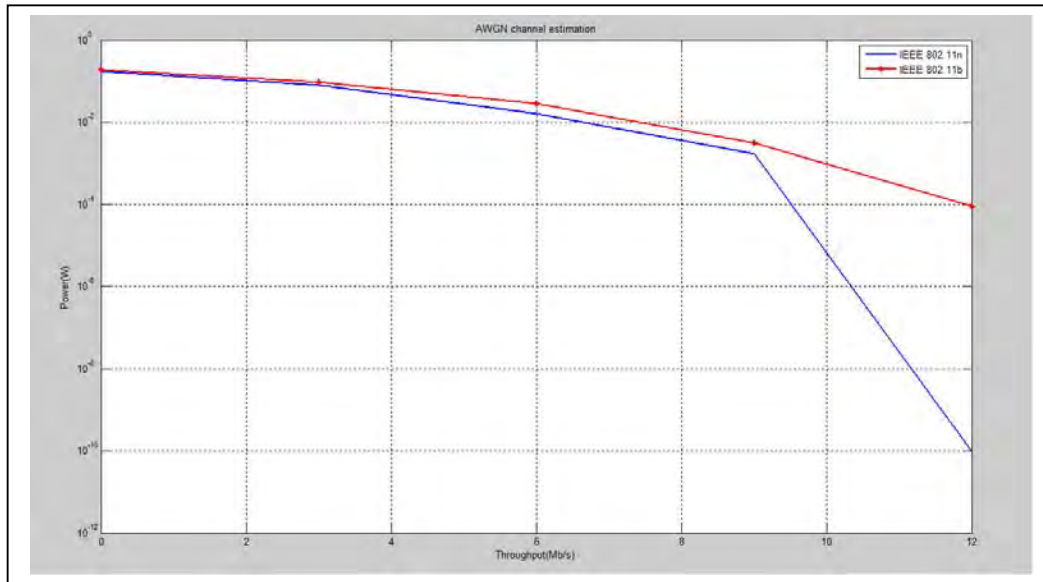


Figure 1. Performance of IEEE 802.11b/n in AWGN channel

The second simulation was also run using the 2.4 GHz signal frequency. But the estimation has been done for a Rayleigh channel.

The figure shows the plot of the throughput achieved and the power consumed while employing IEEE 802.11 b and n standards in the Rayleigh channel. The power consumed for an average throughput of 10 Mbps was 50mW for IEEE 802.11b and 0.01mW for IEEE 802.11n.

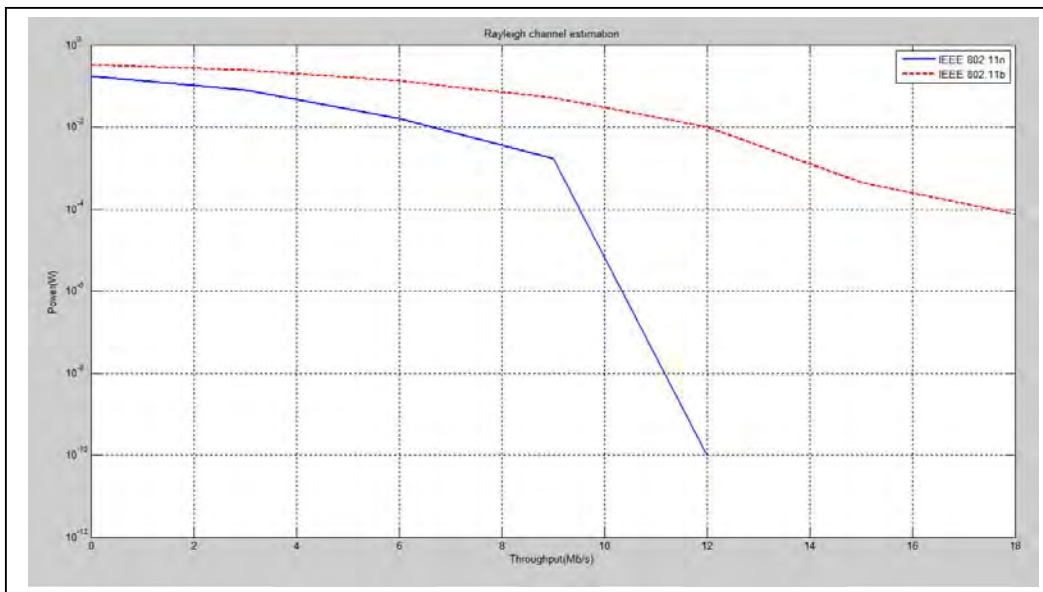


Figure 2. Performance of IEEE 802.11b/n in Rayleigh channel

V. CONCLUSION

In this paper we have evaluated the performance of IEEE 802.11b and n protocols. From the simulation results, it is observed that the IEEE802.11n outperforms IEEE802.11b in terms of power consumption. It is also observed that the power consumed is comparatively less in AWGN channel than in Rayleigh channel. It is found that the optimization of power control increases the life of the battery and maybe achieved by the implementation

of IEEE 802.11n in wireless networks over 802.11b. The reduction in energy consumption will result in better throughput in the network.

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