Performance Enhancement of IEEE 802.11n

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Abstract

This paper contains the various parameters which shows the performance enhancement of 802.11n the latest version of IEEE 802.11 standards. From the latest studies of IEEE 802.11n standard we measured the throughput performance, speed and coverage range. The goal of latest version of 802.11n is also to provide highest data rate. This paper describes detailed description and comparative study of various IEEE 802.11 standards in which there is improvement extensively in the channel efficiency and data throughput. IEEE 802.11n introduces smart radio technology to dramatically increase the quality and speed of the PHY by creating multiple simultaneous data streams.

1. Introduction

Wireless local area networks (WLANs) based on IEEE 802.11 are present in nearly every networking deployment around the world. In previous times the IEEE 802.11 standard is applicable for only WLAN hotspots are shared by multiple users at a time through Medium Access Control (MAC) protocols, and newer versions of the standard have progressively upgraded the available physical channel speeds. In the recent years, wireless LAN (WLAN) is most popular [1]for mobile equipments. Because the equipment cost decreases and the data rate becomes higher. With the successful deployment of IEEE 802.11a/b/g wireless local area networks (WLANs) and the increasing demand for real-time applications over wireless IEEE 802.11 WLAN is most popular network in wireless domain, because of its advantages its system possesses such as interoperability, mobility, flexibility, and cost-effective deployment. THE latest generation of Wireless Local Area Networks (WLANs) is based on the IEEE 802.11n-2009 Standard. The 802.11n standard provides very high data rates at the physical (PHY) layer by using the latest advances in wireless communication. The high data rates are achieved with the Multi-Input Multi-Output (MIMO) PHY layer. MIMO systems use multiple antennae at the transmitting and receiving stations to increase the range and the link capacity. The goal of the 802.11n standard is to leverage the high data rates at the PHY layer to obtain a throughput at the Medium Access Control (MAC) layer that is higher than 100 Mbps. To do that, the Medium Access Control scheme should be efficient with high data rates. IEEE 802.11n is an amendment to the previous standard IEEE 802.11n-2007 wireless standard in which the maximum net data rate increases from 54Mbit/s to 600Mbit/s_ with the use of four spatial streams at a channel width of 40 MHz. This is achieved through the use of multiple transmit and receive antennas, referred to as MIMO (multiple input, multiple output). Using techniques such as spatial division multiplexing (SDM), transmitter beam forming, and space-time block coding (STBC), MIMO is used to increase dramatically throughput over single antenna systems (by two to four times) or to improve range of reception, depending on the environment. Currently the WLAN systems facing difficulties of not overcoming the expectations of [2] users such as video teleconferencing, high definition TV, multimedia streaming and voice over IP(VoIP), online gaming and file transferring. The latest standard IEEE 802.11n is a standard which is overcoming all these aspects by increasing the throughput, MAC efficiency. In this paper we see the throughput MAC/PHY proposal for IEEE 802.1. To achieve higher throughput and better spectral efficiency, not only improvement of the physical layer communications design but also MAC layer enhancements are needed. In this paper, we will examine the enhanced MAC layer design in the IEEE 802.11n systems.

2. About the standards

I. IEEE 802.11 standard

The IEEE 802.11 subcommittee is responsible for the family evolving wireless local area networks. All the IEEE standards are based on different bandwidths.IEEE 802.11n is different from other 802.11 standards because it provides a variety of optional modes. All the different standards of 802.11 such as IEEE 802.11 a/b/g are characterized on the behalf of their speed and bandwidth. The variants of 802.11 all use a common MAC protocol. Other auxiliary standards in the family (c–f, h, I, j) are service enhancements and extensions or corrections to previous specifications.

II. IEEE 802.11n standard

IEEE 802.11n is the most significant change in the wireless LAN world since the adoption of the original standard in 1997. 802.11n defines enhancements for both the MAC and the PHY. The greatest impact of 802.11n is in the technology used for the PHY.802.11n standard gives enhancement in video conferencing, data rates and increases speed of PHY layer. By using additional receivers, sensitivity is increased in proportion to the number of receive Antennas in use. When multiple antennas are used at both the transmitter and receiver (i.e., Multiple Input Multiple Output, or MIMO), spatial multiplexing can be employed to allow additional data to be transmitted without any increase in transmitted power or bandwidth. The greatly enhanced 802.11n PHY introduces a very large number of options for communications between stations based on number of antennas, number of spatial MIMO streams, optional beam forming, modulation method and forward error correction (FEC) coding options. 802.11n certainly fulfills its charter of higher performance.

III. MAC and PHY layer enhancements

The MAC layer must provide a throughput exceeding100Mb/s while ensuring backward compatibility with 802.11a,b,g. It has been shown in previous studies that the throughput of the CSMA/CA based 802.11 MAC for a stream of 1000 byte packets is limited to ~50 Mb/s even with physical layer data rates in excess of 500 Mbps. The MAC layer got enhancement through IEEE 802.11 n standard.

A) Coding and modulation enhancement

The first improved requirement of 802.11 n is provided with OFDM implementation. IEEE 802.11n updates the OFDM methods pioneered by 802.11a for bit and frame encoding. The more efficient OFDM used in 802.11n produces a maximum data rate of 65 Mbps per stream compared to 54 Mbps for 802.11a and 802.11g systems. These changes result in 20% more burst transmission speed.

B) MIMO and spatial Multiplexing

With the changes in the technology more enhanced technologies are needed like MIMO and spatial Multiplexing 802.11n introduces smart radio technology to dramatically increase the quality and speed of the PHY by creating multiple simultaneous data streams. To send more information together from sender to receiver side previous wireless systems have modestly used multiple antennas at the receiver to take advantage of the fact that a transmission from a source to a destination may take multiple paths based on reflections from obstructions in the direct path between source and destination. Previously, multipath has been viewed as a signal impairment that degrades the quality [3]of the radio transmission. The signals does not receive at the receiver side in proper manner. There was no synchronization in sending and receiving signals.802.11n exploits multipath to enhance the delivery of multiple spatial streams 802.11n systems employ MIMO (multiple input, multiple output) which defines multiple transmit and receive radios – each with its own antenna that combine to deliver multiple streams of data between stations on the same channel. By digitally controlling simultaneous transmissions and reception, 802.11n stations can effectively multiply the data rate by the number of simultaneous spatial streams they support. 802.11n defines up to 4 spatial streams.

C) Channel bonding

Channel bonding is introduced to double the burst transmission rate. Channel bonding creates more space for data by bonding or combining together two 20MHz channels into a 40MHz channel. 802.11n allows channel aggregation that bonds two adjacent 20 MHz channels into a single 40 MHz channel in both the 2.4 GHz and 5 GHz bands. Channel bonding increases the data rate because the data rate is directly proportional to the 802.11 a/b/g using single 20 MHz.

On IEEE 802.11n, a mode with a channel width of 40 MHz is specified. This is not channel bonding, but a single channel with double the older 20 MHz channel width, thus using two adjacent 20 MHz bands. This allows direct doubling of the PHY data rate from a single 20 MHz channel, but the MAC and user level throughput also depends on other factors so may not double.

D) Beam forming

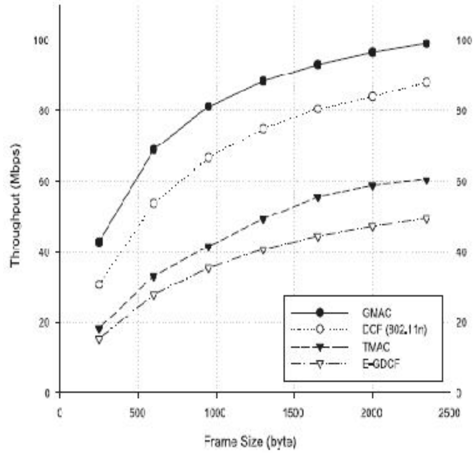
As 802.11n systems emerges in the market as an important feature for enterprise Wi-Fi infrastructure. Beam forming is an important companion to 4x4 Multiple Input Multiple Output (MIMO) technologies for Wi-Fi wireless networking. When it is included, it enables dramatic improvement in Wi-Fi 802.11ac/n performance, reliability, range and coverage. Beam forming is an optional feature of 802.11n. In its simplest terms, beam forming allows an access point to effectively concentrate its signal at the client's location. This results in a better signal, SNR and potentially a great throughput. It is a natural extension of the physical layer that has multiple radios and antennas in each station. By controlling the transmit power and phase of the collection of transmission antennas, it is possible to shape the effective gain of the antennas to create a pattern that points towards the receiving station a beam.

E) Frame Aggregation

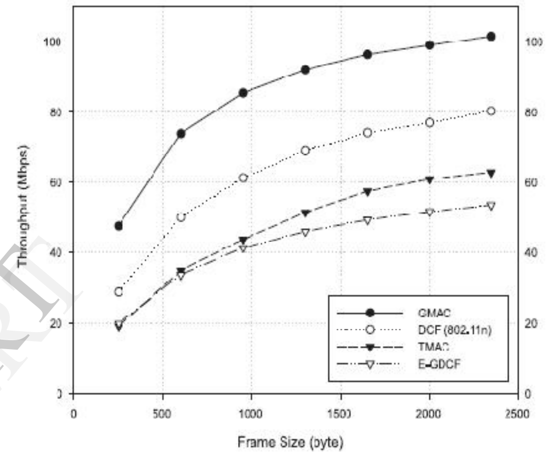
The 802.11n MAC allows successive frames to be combined and supports frames up to 64 k bytes with the Aggregated MAC Protocol Data Unit.

3. Simulation Results

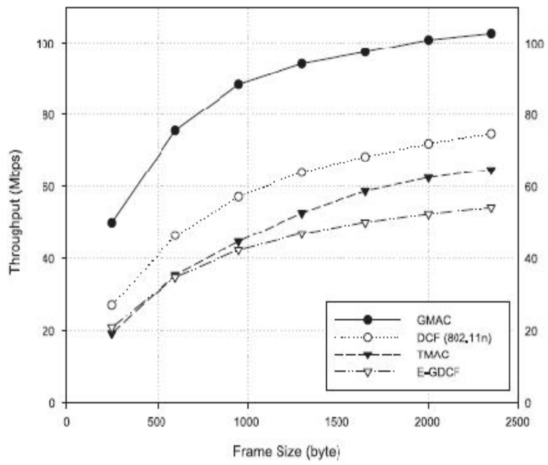
From the simulation results we observed that the parameters such as throughput increases with the changes in number of stations.



(a) Throughput (number of stations is 8)



(b) Throughput (number of stations is 40)



(c) Throughput (number of stations is 120)

Conclusion

The application of Wireless LANs (WLANs) based on IEEE 802.11 can be widely expanded by adopting newer PHY layer technologies and improving the design of the MAC layer. In this paper we are studying about advantages of IEEE 802.11n standard over all other IEEE 802.11 standard. The Beam forming, frame aggregation, channel bonding such parameters of IEEE 802.11n shows a very advanced improvements. Through results we analyzed that the enhancements enable the support of several flows with high throughput and low latency requirements.

4. References

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