Performance Evaluation of IEEE802.11n WLANs Based on Aggregation Method

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الملخص:

يعد تعديل IEEE 802.11n حاليًا الحل الأكثر فعالية ضمن نطاق الشبكات المحلية اللاسلكية .(LAN) يوفر المعيار العديد من التحسينات ويتم تحسينه بطرق عديدة. أحد الأهداف الرئيسية لهذه التحسينات هو الحصول على أداء عالي للإنتاجية وتأخير أقل لطبقة .MAC الهدف الرئيسي من هذا البحث هو تقييم أداء الشبكات المحلية العالية السرعة (IEEE 802.11n) من حيث طريقة التجميع. يهدف IEEE 802.11n إلى دعم تجميع الإطار. الذي يجمع الحزم في إطار كبير يسمى (A-MSDU)وحدة بيانات خدمات MAC التجميعية ويجمع الإطارات في إطار كبير يسمى (A-MPDU) وحدة بيانات بروتوكول تجميعMAC ، وهما ميزتا الأداء الرئيسيتان هما القدرة على تعزيز النفقات العامة للإرسال في طبقة MAC عبر قناة صاخبة. يتم فحص النظام عن طريق المحاكاة باستخدام .NS-2.34 تظهر نتائج المحاكاة أن المخططات المقترحة تحسن بشكل كبير الأداء على وظيفة التنسيق الموزعة (DCF) وطريقة A-MSDU تحسن بشكل كبير لأداء الإنتاجية مقارنة بالدراسات السابقة حتى 103.16٪ بينما تعمل طريقة A-MPDU على تحسين أداء الإنتاجية مقارنة بالدراسات السابقة حتى 155.15%. في الختام، حقق هذا البحث هدفه المتمثل في تقييم أداء الشبكات المحلية العالية السرعة (IEEE 802.11n) من حيث طريقة التجميع.

Abstract

IEEE 802.11n amendment is currently the most effective solution within the range of Wireless Local Area Networks (LAN). The standard provides many enhancements and is improved upon in many ways. One of the main goals of these improvements is to get high performance of Throughput and less delay of the MAC layer. The main objective of this research is to evaluate the performance of very high-speed WLANs (IEEE 802.11n) in terms of the aggregation method. IEEE 802.11n is intended to support frame aggregation which combines the packets into a large frame called (A-MSDU) aggregation MAC services data unit and aggregates the frames into a large frame called (A-MPDU) Aggregation MAC protocol data unit, which are the two key performance features are the ability to enhance the transmission overheads in MAC layer over a noisy channel. The system is examined by simulation using NS-2.34. The simulation results show that the proposed schemes significantly improve the performance over distributed coordination function (DCF) and the A-MSDU method significantly improves the performance of throughput over the literature scheme up to 103.16% while the A-MPDU method improves the performance of throughput over the literature scheme up to 155.15%. In conclusion, this research has achieved its stated objective of evaluating the performance of very high-speed WLANs (IEEE 802.11n) in terms of the aggregation method. Additionally, the proposed schemes show a significant improvement compared with a literature scheme.

Keywords: IEEE 802.11, Aggregation, MAC

Introduction

Wireless local area networking (WLAN) has expanded rapidly in the past few years due to advancements in semiconductor technology and WLAN standardization with IEEE 802.11, which have significantly decreased costs and improved WLAN use. Installing network access lines in an existing building may require tearing down floors, ceilings, or walls, which is expensive and cumbersome. However, setting up a single wireless access point is frequently enough to provide wireless network connectivity in these types of settings. These days, 802.11b, 802.11g, and 802.11a standard modifications—which offer throughput gains over the original 802.11—form the basis of the great majority of WLAN products and systems. 802.11n was developed for the majority of modern applications, marking another advancement in WLAN technology (Milad, 2017). The IEEE 802.11n standard is a The IEEE 802.11 Working Group uses a modified version of IEEE 802.11 with high throughput and high speed. With a technological trend toward higher bandwidths, IEEE802.11-based WLANs seek to offer rich applications, such as TCP applications (100 Mb/s) and HDTV (20 Mb/s). Recent very high WLAN proposals aim to provide up to 600 Mbps of physical (PHY) layer speed support [1, 2].

IEEE 802.11 These days, one of the most important access network technologies on the Internet is wireless LANs, which are ubiquitous in homes, offices, educational settings, coffee shops, airports, and street corners. The 1990s saw the development of numerous wireless LAN technologies and standards, but one class of standards—the IEEE 802.11 wireless LAN, or WIFI—has unquestionably come out on top. This section will examine 802.11 wireless local area networks (LANs) in detail, including an analysis of their frame structure, medium access protocol, and internetworking. (Milad, 2013, “Reverse Direction Transmission”)

For wireless LAN technologies, there are multiple 802.11 standards, such as 802.11b, 802.11a, 802.11g, and 802.11e. Numerous features are shared by the 802.11 standards. They all employ the same frame structure for their link-layer frames in addition to using the same medium access protocol, Carrier Sense Multiple Access Collision Avoidances, or CSMA/CA. To communicate over longer distances, all of these standards have the ability to lower their transmission rates. (Sadeghi, 2017).

While 802.11a wireless LANs can run at far higher frequencies and much greater bit rates, 802.11b wireless LANs have a data rate of 11 Mbps and use the 2.4–2.485 GHz unlicensed frequency band. 802.11a LANs have a shorter transmission distance at a given power level because they operate at a higher frequency. In order to allow 802.11b clients to be upgraded gradually, 802.11g LANs are backward compatible with 802.11b and operate in the same low-frequency range as 802.11b (Li, 2005). The data frames in IEEE 802.11e are transmitted in independent, consecutive ways. Additionally, Block ACK (BA) acknowledges these data frames following the sender's BAR transmission.(Li, 2005).

An ongoing next-generation wireless LAN standard is IEEE 802.11n. IEEE 802.11n aims to increase PHY and MAC performance while prioritizing high throughput over high rates (Ali, 2016). Numerous improvements are offered by IEEE802.11n to lower the MAC layer overhead. A few packets and frames are combined into one big frame for transmission using frame aggregation. A block of data frames known as a block acknowledgement (BA) is delivered sequentially to the destination following the transfer of the block of data. To find out which frame the recipient has received, the sender sends the BA request (BAR). The BA is then returned to the sender. (Li, 2006), (Ali, 2016).

The significance of IEEE 802.11n technology and its features have greatly aided all types of applications.

Literature review

In this paper, the researchers performed a comprehensive review of the current limitations of the wireless networks and how these limitations led to the introduction of more efficient techniques for improving the network performance.

WLANs has developed in recent years with the increase of IEEE 802.11 devices. In the next century, communication of radio and radar proved to be invaluable to the military, which included the development of spread spectrum technology. The first created packet in WLANs ALOHANET was in 1971 in University of Hawaii. Communicated seven nodes (Computers) over 4 island connected with server using star topology in reverse direction transmission (Perahia, 2013), (Milad, 2015).

An achievement occasion for business WLANs occurred in 1985 when the US Government Correspondences Commission (GCC) permitted the utilization of the exploratory modern, logical, and clinical radio groups for the business use of spread range innovation. A few generations of restrictive WLAN devices created to utilize these groups, including Wave LAN by Bell Labs. These initial systems were expensive and their implementation was only feasible when it was hard to run cables (Zhu, 2016, “A Noval Method”).

Development in semiconductor technology and the standardization of WLANs with IEEE 802.11 have led to dramatic cost reductions and increased acceptance of WLAN technology. With the rising business interest, the Wi-Fi Coalition was framed in 1999 to guarantee interoperability among IEEE 802.11 devices from various producers through testing. Since 2000, shipments of Wi-Fi ensured coordinated circuits (IC) came to 200 million every year in 2006 shipments are reached to a billion units per year by 2012 (Zhu, 2016, “A Noval Method”).

Such large and sustained growth is due to the benefits WLANs offer over wired networking. In existing homes, universities and enterprises, deploying cables for network access may cause holes in walls, floors, or ceilings, which is both inconvenient and costly. Conversely, giving WLANs in these conditions is frequently pretty much as straightforward as introducing a WAP wireless access point.

The proliferation of laptops and mobiles led to people desiring connectivity wherever they are located, not just where the network connection is located. Network connectivity in a conference room or while seated on the sofa in the living room are just two examples of the flexibility afforded by WLANs (Zhu, 2016, “A Noval Method”).

Most WLAN products and systems today are depending on the 802.11b, 802.11g, and 802.11a standard amendments, which provide throughput enhancements over the original 802.11 PHYs. Progress in WLAN technology continues with the development of 802.11n (Zhu, 2016, “Performance analysis”) .

The IEEE 802.11 working group began development of a common medium access control (MAC) layer for multiple physical layers (PHY) to standardize wireless local area networking. As a member of the IEEE 802 family of local area networking (LAN) and metropolitan area networking (MAN) standards, 802.11 interfaces with 802.1 architecture, management, and interworking, and 802.2 logical link control (LLC). The combination of 802.2 LLC and 802.11 MAC and PHY make up the data link and physical layers of the Open Systems Interconnection (OSI) reference model, as described in Table 1.1 (Perahia, 2013).

Table 2.1: OSI Layers (Zimmerman, 1980; Teare, 1999)

OSI layers	Description	Examples	Layer classes
Application	Interacts with software applications that implement a communicating component	Telnet, FTP. SMTP	Application
Presentation	Coding and conversion functions that are applied to application layer data	Quicklime. MPEG, GIF, JPEG, TIFF	
Session	Establishes, manages, and terminates communication sessions	ZIP, AppleTalk, SCP, DECnet Phase IV	
Transport	Acknowledges information from the meeting layer and sections the information for transport across the network	TCP, UDP	Data transport
Network	Defines the network address	IP, IPv6	
Data link	Transit of data across a physical network link V	802.2 LLC	
		802.11 MAC	
Physical	Electrical, mechanical. procedural. and functional specifications	802.11 PHY	

The initial version of the 802.11 standard was completed in 1997. Affected by the immense market outcome of Ethernet (normalized as IEEE 802.3), the 802.11 took on a similar basic protocol of Distributed Coordination function (DCF) of carrier sense multiple access (CSMA). With CSMA, a station wishing to transmit first listens to the medium for a predetermined period. The station is permitted to transmit when the medium is sensed to be “idle” during this period. the station defers its transmission when the medium is sensed to be “busy,". The shared medium of ethernet utilized a variety called carrier sense multiple access with collision detection CSMA/CD.

After determining that the medium is “idle” and transmitting, the station is able to receive its own transmission and detect collisions. If a collision is detected, the two colliding stations backoff for a random period before transmitting again. The second collision was reduced by the random backoff. With wireless it is not possible to detect a collision with one’s own transmission directly in this way: thus 802.11 uses a variation called CSMA/CA or carrier sense multiple access with collision avoidance. With CSMA/CA, if the station detects that the medium is busy, it defers its transmission for a random period following the medium going “idle” again. This methodology of continuously easing off for an irregular period following one more station's transmission further develops execution since the punishment for an impact is a lot higher on a remote LAN than on a wired LAN (Milad, 2013, "Design a Novel Reverse").

On a Wired LAN impacts are distinguished electrically and hence very quickly, while on remote

LAN crashes are deduced through the absence of an affirmation or other reaction from the remote station once the total casing has been sent. There is no doubt that the simplicity of this distributed access protocol, which enables consistent implementation across all nodes, significantly contributed to Ethernet's rapid adoption as the industry LAN standard. Likewise, the adoption by the industry of 802.11 as the wireless LAN standard is in no small part due to the simplicity of this access protocol, its similarity to Ethernet, and again the consistent implementation across all nodes that has allowed 802.11 to beat out the more complex, centrally coordinated access protocols of competing WLAN technologies such as Hyper LAN.

The standard of (1997) 802.11 included three physicals: infrared (IR), 2.4 GHz frequency hopped spread spectrum (FHSS), and sequence spread spectrum 2.4 GHz direct (DSSS). This was trailed by two standard revisions in 1999: 802.11b based upon DSSS to build 2.4 GHz rate and 802.11a to make new PHY in 5 GHz. 802.11b improved DSSS with (CCK), expanding the information rate to 11 Mbps.With higher data rates, IEEE 802.11b devices achieved significant market achievement, and markets for IR and FHSS PHYs didn't appear.

The advancement of 802.11a presented symmetrical recurrence division multiplexing (OFDM) to 802.11. Even though 802.11a introduced data rates of up to 54 Mbps, it is confined to the 5 GHz band and, as a result, adoption has been slow. New devices would need to take advantage of the higher rates supported by 802.11a but retain backward compatibility with the huge installed base of 802.11b devices wish to implement two radios, one to operate using 802.11b in the 2.4 GHz band and the other to operate using 802.11a in the 5 GHz band. Furthermore, international frequency laws in the 2.4 GHz band uniformly allowed commercial use, whereas in 1999 and 2000 the non-military use of the 5 GHz band was limited to select channels in the United States (Negus, 2009).

Table 2.2: Overview of 802.11 PHYs

	Table 1.2 Overview of 802.11 PHYs				
	802.11	802.11b	802.11a	802.11g	802.11n
PHY technology	DSSS	DSSS/CCK	OFDM	OFDM DSSS/CCK	SDM/OFDM
Data rates	1, 2 Mbps	5.5, 11 Mbps	6–54 Mbps	1–54 Mbps	6–600 Mbps
Frequency band	2.4 GHz	2.4 GHz	5 GHz	2.4 GHz	2.4 and 5 GHz
Channel spacing	25 MHz	25 MHz	20 MHz	25 MHz	20 and 40 MHz

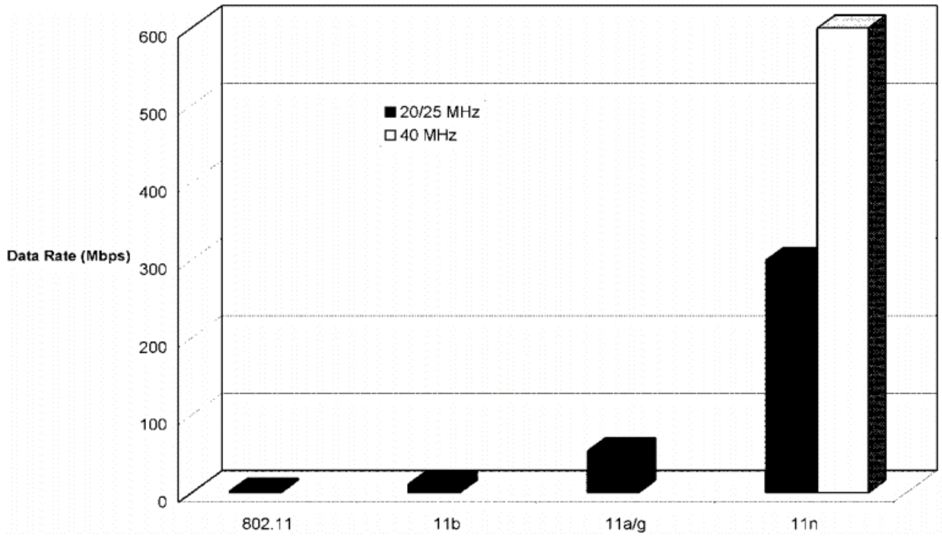

Figure1: Increasing data rate in IEEE 802.11n (Milad, 2017)

In 2001, the FCC permitted the use of OFDM in the 2.4 GHz band. Subsequently, the 802.11 working group developed the 802.11g amendment, which incorporates the 802.11a OFDM PHY in the 2.4 GHz band and adopted it as part of the standard in 2003. In addition, backward compatibility and interoperability is maintained between 802.11g and the older 802.11b devices. This allows for new 802.11g client cards to work in existing 802.11b hotspots, or older 802.11b embedded client devices to connect with a new 802.11g access point (AP). Because of this and new data rates of up to 54 Mbps, 802.11g has experienced large market success. A summary of the high-level features of each PHY is given in Table 1.2. With the adoption of each new PHY, 802.11 has experienced a five-fold increase in data rate. This rate of increase continues with 802.11n with a data rate of 300 Mbps in 20 MHz and 600 Mbps in 40 MHz. The exponential rate of increase in data rate is illustrated in Figure 1 (Negus, 2009).

Interest in a high data rate extension to 802.11a began with a presentation to the Wireless Next Generation Standing Committee (WNG SC) of IEEE 802.11 in January 2002. Market drivers were outlined, such as increasing data rates of wired Ethernet, more data rate intensive applications, non-standard 100+ Mbps products entering the market, and the need for higher capacity WLAN networks. The presentation mentioned techniques such as spatial multiplexing and doubling the bandwidth as potential approaches to study for increasing data rate (Perahia, 2008).

The initial version of the 802.11 standard Influenced by the huge market success of Ethernet (standardized as IEEE 802.3), the 802.11 MAC adopted the same simple distributed access protocol, carrier sense multiple access (CSMA). With CSMA, a station wishing to transmit first the medium was listened for a foreordained period. In the event that the medium is detected to be "inactive" during this period, the station is allowed to send. On the off chance that the medium is detected to be "occupied," the station needs to concede its transmission. The first (shared medium) Ethernet utilized a variety called CSMA/Disc or transporter sense numerous entrances with crash location. After determining that the medium is “idle” and transmitting, the station is able to receive its own transmission and detect collisions. If a collision is detected, the two colliding stations backoff for a random period before transmitting again. The random backoff period reduces the probability of a second collision (Mehrnoush, 2018).

The medium access control (MAC) layer provides, among other things, addressing and channel access control that makes it possible for multiple stations on a network to communicate.IEEE 802.11 is frequently alluded to as remote Ethernet and, as far as tending to and channel access, 802.11 is for sure like Ethernet, which was normalized as IEEE 802.3. As an individual from the IEEE 802 LAN family, IEEE 802.11 utilizes the IEEE 802 48-piece worldwide location space, making it viable with Ethernet at the connection layer. The 802.11 Macintosh likewise upholds shared admittance to the remote medium through a method (CSMA/CA), which is like the first (shared medium) (CSMA/Cd). With the two procedures, in the event that the channel is detected to be "inactive," the station is allowed to communicate, however on the off chance that the channel is detected to be "occupied" the station concedes its transmission. In any case, the totally different media over which Ethernet and 802.11 work intend that there are a few distinctions. The Ethernet channel access convention is basically to trust that the medium will go "inactive," start sending and, assuming that an impact is distinguished while communicating, to quit sending and start an irregular backoff period. It isn't practical for a transmitter to identify an impact while sending in a remote medium; hence the 802.11 endeavors to stay away from crashes. When the medium goes "inactive," the station holds up an irregular period during which it keeps on detecting the medium, and if toward the finish of that period the medium is still "inactive," it starts sending. The irregular time frame diminishes the possibilities of a crash since another station holding on to get to the medium would probably pick an alternate period, subsequently the impact evasion part of CSMA/CA.

The simple distributed, contention-based access protocol supported by the CSMA/CA technique is the basis for the 802.11 MAC protocol and also where the similarity to Ethernet ends (Eldeeb, 2020)-18]. The wireless medium, being very different from the wired medium, necessitates a number of additional features (MA, 2019):

1- The wireless medium is prone to errors and benefits significantly from having a low latency, link level error recovery mechanism.
2- In a wireless medium not all stations can “hear” all other stations. Some stations may “hear” the station on one end of an exchange but not the station at the far end (the hidden node problem).
3- The data rate that a channel can support is affected greatly by distance and other environmental effects. Also, channel conditions may change with time due to station mobility or environmental changes. Stations need to continually adjust the data rate at which they exchange information to optimize throughput.
4- Stations, often being mobile, need management mechanisms for associating with and disassociating from WLANs as they change location.

The specific CSMA/CA mechanism used in the 802.11 MAC is referred to as the distributed coordination function (DCF). A station that wishes to transmit first performs a clear channel assessment (CCA) by sensing the medium for a fixed duration, the DCF inter-frame space (DIFS). If the medium is idle, then the station assumes that it may take ownership of the medium and begin a frame exchange sequence. If the medium is busy, the station waits for the medium to go idle, defers for DIFS, and waits for a further random backoff period. If the medium remains idle for the DIFS deferral and the backoff period, the station assumes that it may take ownership of the medium and begin a frame exchange sequence. The random backoff period provides the collision avoidance aspect. When the network is loaded, multiple stations may be waiting for the medium to go idle having accumulated packets to send while the medium was busy. Since each station probabilistically selects a different backoff interval, collisions, where more than one station begins transmission at the same time, are unlikely. When a station has accessed the medium, it keeps up with control of the medium by keeping a base hole, the short inerframe space (SIFS), between frames in a succession. Another station won't get to the medium during that grouping since it should concede for a decent length that is longer than SIFS. Rules limit the kinds of casing trade successions that are permitted and the length of those groupings to keep one station from consuming the medium (Bianchi, 2000), (Ali, 2015). Fundamental to CSMA/CA is the carrier sense. The DCF uses both physical and virtual carrier sense functions to determine the state of the medium. The physical carrier sense resides in the PHY and utilizes energy identify and prelude distinguish with frame length deferral to decide when the medium is occupied. The virtual transporter sense dwells in the MAC and utilizations reservation data conveyed in the Length field of the MAC headers reporting hindering utilization of the medium. The virtual transporter sense component is known as network allocation vector (NAV) (Pollin, 2008). The DCF also makes use of the immediate feedback provided by the basic acknowledgement mechanism that has the responder send an ACK frame in response to the initiator's data or management frame. Not receiving the ACK response frame is a likely indication that the initiator's transmission was not correctly received, either due to collision or poor channel conditions at the time of the data transmission (Karmakar, 2017).

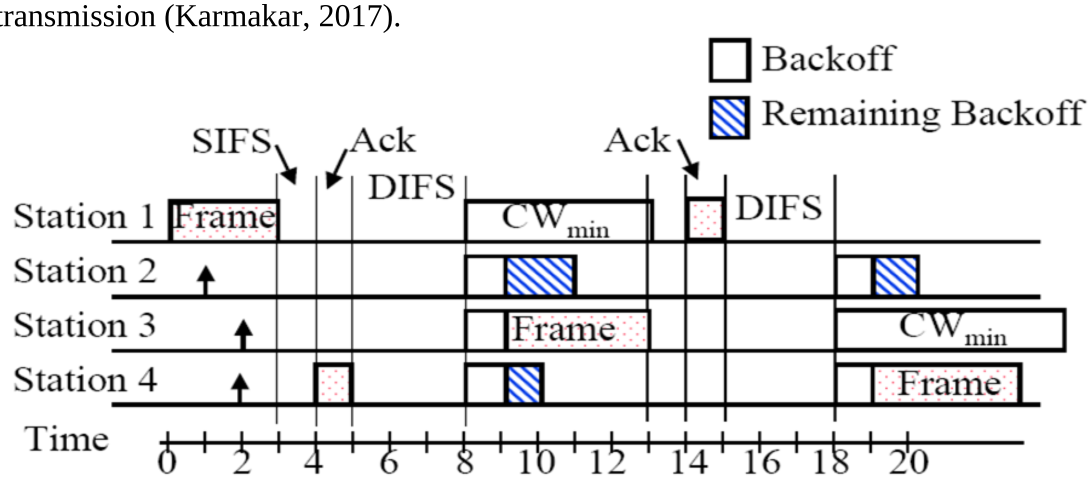

Figure 2: The carrier sense is the foundation of CSMA/CA. Physical and virtual carrier sense (Milad, 2013)

Simulation Design

IEEE 802.11n has improved the efficiency of the MAC (Media Access Control) protocol using a single ACK mechanism for multiple frames and ability to aggregate multiple frames into a single transmission (Kolap, 2012).

Frame aggregation is defined as an application that combines packets and frames into a large individual frame for transfer. The process is performed by using two available procedures: aggregate MAC SDU (A-MSDU) and aggregate MAC PDU (A-MPDU)(Lee, 2011).

At the top of the MAC is MSDU aggregation (or A-MSDU), which in the egress direction aggregates MSDUs as the first step in forming an MPDU. At the bottom of the MAC is MPDU aggregation (or A-MPDU), which in the egress direction aggregates multiple MPDUs (Perahia, 2013).

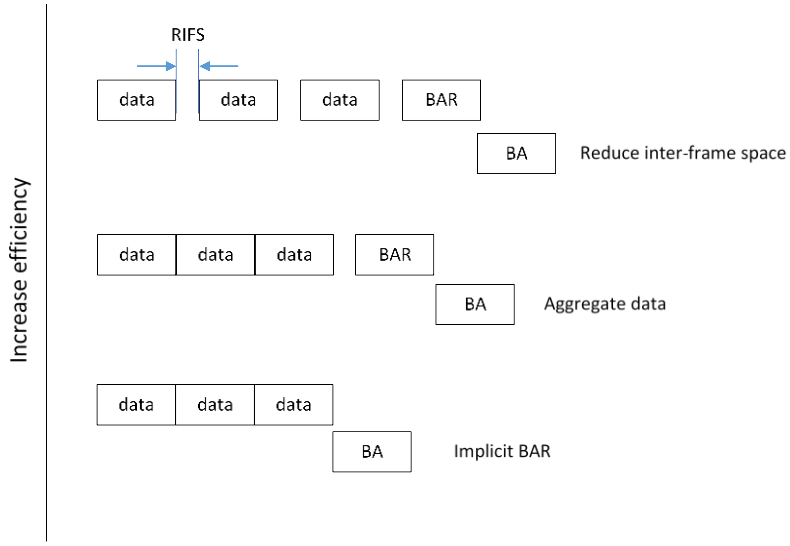

Figure 3: IEEE 802.11n increasing efficiency {, 2009 #62}

The proposed schemes focus mainly on the aggregation method. which combines the packets into a large frame called (A-MSDU) aggregation MAC services data unit and aggregates the frames into a large frame called (A-MPDU) Aggregation MAC protocol data unit, which are the two key performance features are the ability to enhance the transmission overheads in MAC layer over a noisy channel, and this provides an enhancement to reduce the overhead at the MAC layer.

The existing scheme which described in previous paragraph is enhanced by the proposed schemes because it becomes more efficient from different aspects.

In the Aggregated MAC service data units, A-MSDU scheme, multiple MSDUs are bundled to form a MPDU which could consist of multiple sub frames either from multiple sources or for multiple destinations. An A-MSDU consists of multiple sub frames (i.e. multiple MSDUs). Each sub frame of an A-MSDU has a sub header (Destination address, Source Address, (Length), MSDU, and padding bytes. The size of the MSDU in each subframe can be different. Different sizes of MSDUs in each subframe are aggregated. To make the length of the sub frame in multiple of 4 bytes except for the last sub frame the padding bytes are appended. All the sub frames are bundled and share a common MAC header and frame check sequence (FCS) which is calculated over all the sub frames and a common MAC header and then appended as the trailer.

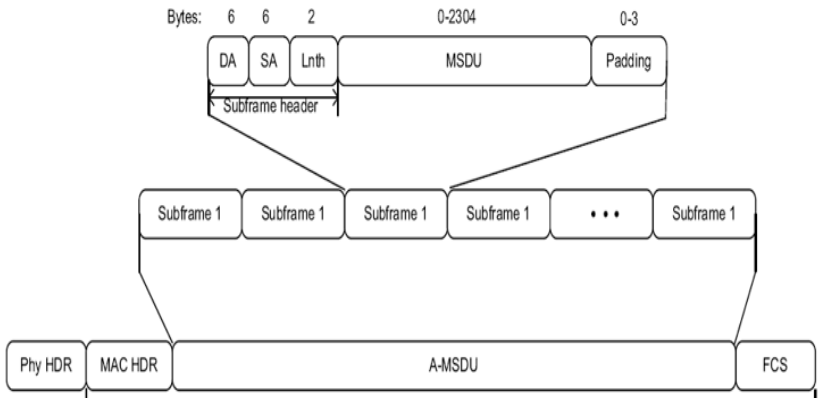

Figure 4: A-MSDU Frame structure

Figure 5 illustrates the ACK format in the A-MSDU scheme where the lost fragments are indicated in a bitmap field at ACK. This bitmap field size to save each subframe is 32 bytes. When the ACK is received, the sender's MAC checks the ACK bitmap field and updates the Sq by marking received subframe correctly as "delivered". The MAC then removes the successfully received packets from the Sq and keeps the unsuccessful ones. The sender checks the FCS of each subframe received from receiver. The sender sends the unsuccessful packets while indicating the corrupted subframes in ACK bitmap and excluding the corrupted subframes from the sender in the first stage.

2	2	6	32	4
Frame Control	Duration	Receiver Address	Fragment bitmap	FCS

Figure 5: ACK Format in A-MSDU

The concept of A-MPDU aggregation is to join multiple MPDU subframes with a single leading PHY header. A key difference from A-MSDU aggregation is that A-MPDU functions after the MAC header encapsulation process. Consequently, the A-MSDU restriction of aggregating frames with matching TIDs is not a factor with A-MPDUs. However, all the MPDUs within an A-MPDU must be addressed to the same receiver address. Also, there is no waiting/holding time to form an A-MPDU so the number of MPDUs to be aggregated totally depends on the number of packets already in the transmission queue. The maximum length that an A-MPDU can obtain — in other words the maximum length of the PSDU that may be received is 65,536 bytes, but it can be further constrained according to the capabilities of the STA found in the HT capabilities element. The utmost number of subframes that it can hold is 64 because a block ACK bitmap field is 128 bytes in length, where each frame is mapped using two bytes. Note that these two bytes are required to acknowledge up to 16 fragments but because A-MPDU does not allow fragmentation, these extra bits are excessive. As a result, a new variant has been implemented, known as compressed block ACK with a bitmap field of eight bytes long. Finally, the size of each subframe is limited to 4095 bytes as the length of a PPDU cannot exceed the 5.46-ms time limit; this can be derived from the maximum length divided by the lowest PHY rate, which is 6 Mb/s and is the highest duration of an MPDU in 802.11a (Skordoulis, 2008).

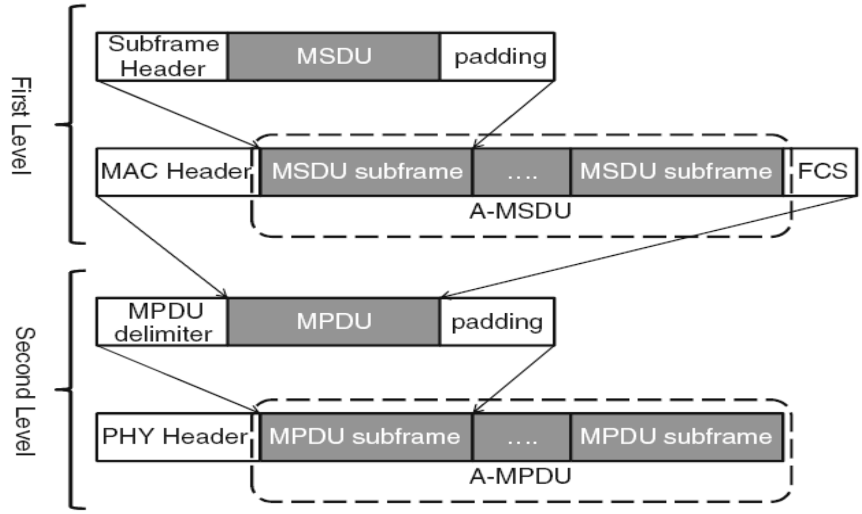

Figure 6: A-MPDU Frame structure.

As illustrated in Figure 7, a BA bitmap field is implemented into the BA frame to let the transmitter know which subframes have been lost in a block of data and mainly to indicate which MPDU subframe has succeeded and which one has failed. To include all the data, the size of the bitmap should be sufficient at 128 bytes.

2	2	6	6	2	2	128	4
Frame Control	Duration	Receiver Address	Sender Address	BA Control	BA starting Sequence Control	BA Bitmap	FCS

Figure 7: ACK Format in A-MSDU

According to the standard 802.11n, the maximum MAC frame size for A-MSDU is 8192 bytes and A-MPDU is 65536 bytes when the aggregation unit is used for both packets and frames [27].

Findings:

Simulation experiments are conducted to evaluate the A-MSDU and A-MPDU performance under different frame sizes and number of stations. The results are compared to the standard 802.11n where DCF are under the same conditions. The results are reported in different TCP traffic. Table 4.1 list the parameters that have been used in the NS-2 simulation.

Table 4.1: NS2 Parameters

Traffic Type	TCP
Number of Stations	50, 60, 70 ….100
Basic Rate	54 Mbps
Data Rate	600 Mbps
Packet Size	1024 bytes
A-MSDU Frame size	8192 bytes
A-MPDU Frame size	65536 bytes
DCF Frame Size	1024 bytes
BER	10^{-5}

Figure 8 shows the performance throughput of proposed schemes with different numbers of stations. The frame size is kept at 1024 bytes, and the other parameters are listed in Table 4.1 All the stations share a common medium. This throughput is achieved by the whole system rather than by a single station. The throughput of A-MPDU achieves high performance compared with the other schemes. The throughput of A-MPDU achieves 88 Mbps at 50 stations. The performance decreases to 77 Mbps in 100 stations. The throughput performance of A-MSDU reaches 66 Mbps at 50 stations and then decreases to 60 Mbps at 100 stations. The throughput of the standard of IEEE 802.11n (DCF) achieves 33 Mbps when at 50 stations. The performance decreases to 30 Mbps at 100 stations. The performance of the proposed schemes showed that the aggregation method was significant compared with the literature scheme.

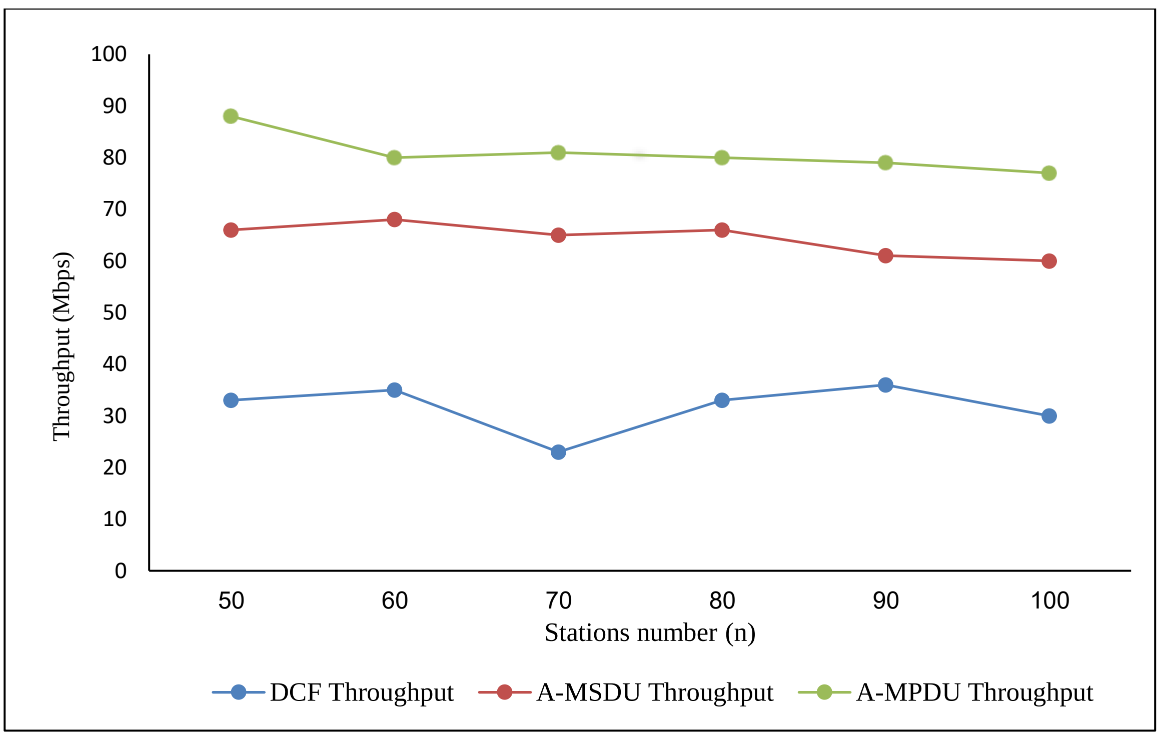

Figure 8: Throughput compared Number of Stations

Figure 9 depicts the evaluation of the scheme's throughput with different frame sizes in 50 stations. All stations share a common communication medium, that is, each of which performed an FTP download. The other parameters are listed in Table 4.1. The A-MPDU and A-MSDU schemes achieve the highest performance compared with the literature schemes. The throughput of A-MPDU reaches 77 Mbps when the frame size is 256 bytes and increases when the frame size increases too. The performance of A-MSDU increased until the frame size of 8192 bytes suddenly decreased to zero. As same as DCF scheme performance increased until 1024 byte then decreased too. The A-MPDU throughput performance obtains high efficiency compared with the previous schemes.

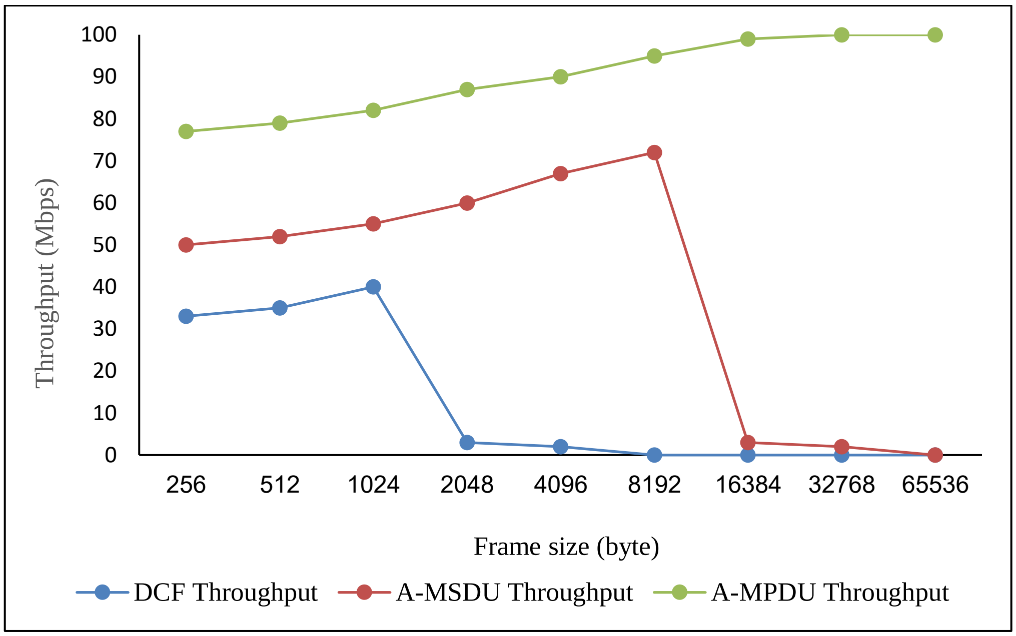

Figure 9: Throughput compared Frame size

The delay of the A-MPDU and A-MSDU with the literature scheme is compared with that of the different stations (Figure 10). The frame size is adopted at 1024 bytes. and other parameters are listed in Table 4.1 The A-MSDU scheme scores the lowest delay because its data size is lower than A-MPDU with the aggregation method. The average delay increases with the increasing number of stations because of the increase in contention time for DCF.

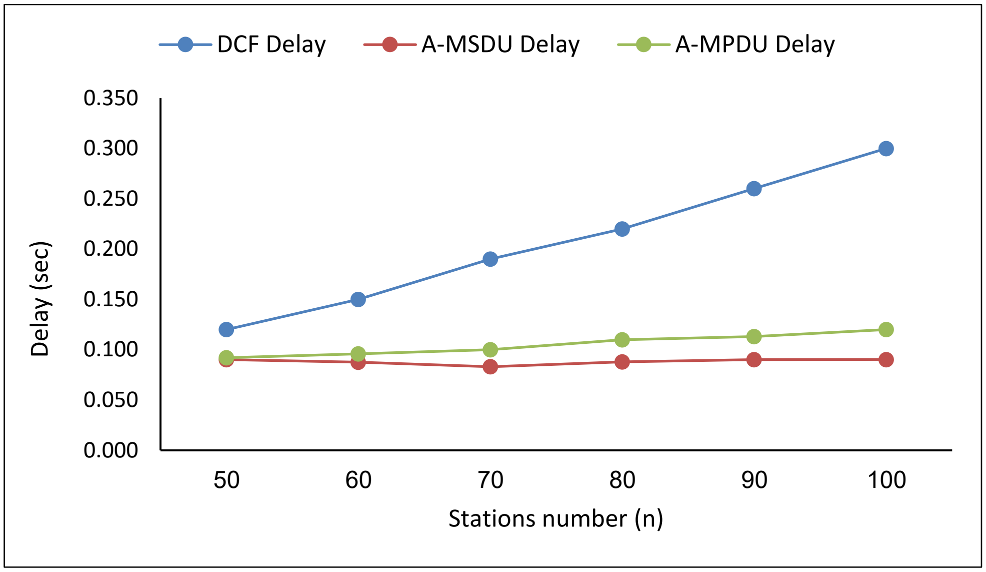

Figure 10: Delay compared the number of Stations

Figure 11 illustrates the proposed schemes delay in performance and compares it to different frame sizes. A total of 50 stations are used. The other parameters are listed in Table 4.1. A- MSDU achieves lower delay than the other schemes. in which an increase in the size of the frame corresponds to the increase in delay. Conversely, The DCF achieved high delay because there is no aggregation method used. Therefore, small frame sizes have a small transmission delay time.

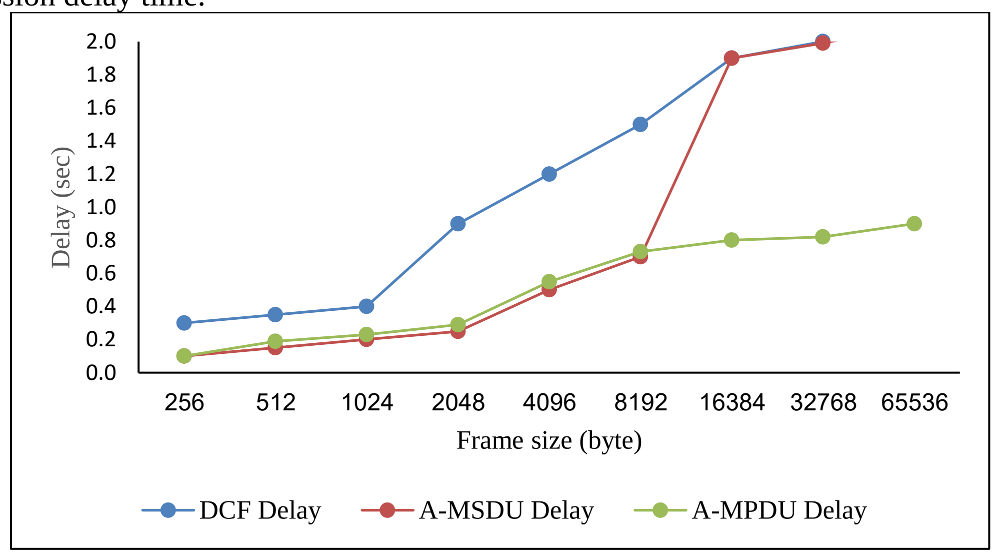

Figure 11: Delay compared Frame size

Conclusion:

Initially, it was thought that IEEE 802.11 wireless networks' physical data rates would increase, thus, improving the network's throughput. Nevertheless, the findings showed that even when the data rates reach extremely high levels, the network throughput saturates at a certain point, as such, the current IEEE 802.11 function is not designed to handle these large data rates adequately. Therefore, it would not be advantageous to increase the data rates without making significant improvements to the MAC layer. An analysis was conducted on IEEE 802.11's performance, and the source of the limitations was found. The findings demonstrate that the IEEE 802.11's inefficient performance is a result of the existing DCF function. The DCF uses a time overhead that rises in direct proportion to the data rates, The suggested plans were presented in an effort to reduce this overhead. The main goal of this research is to use a simulation with NS-2.34 to improve the MAC layer for IEEE 802.11n. A-MSDU and A-MPDU aggregation techniques have been developed and implemented. Both approaches aim to combine as many packets and frames from the higher layer as possible into a single, huge frame. The purpose of the simulation is to compare the results of the earlier study on the competition system (DCF) and to access the throughput and delay of A-MSDU and A-MPDU across a noisy channel. The results show that both strategies are producing large throughput with minimal latency. Examined has also been the effect of suggested techniques on TCP application performance, especially via stimulation.

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