Volume 2, Issue 3, March 2012 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Enhancement of QoS Performance in Wireless LAN: Analysis

Shobhit Sharma
Department of Instrumentation & Control Engineering
Dr.B.R.Ambedkar National Institute of Technology,
Jalandhar, India
shobhitsharma.icici@gmail.com

***Abstract*—Wireless local area network (WLAN) has become more popular in recent years. With increase in demand users are expecting quality of service (QoS) for multimedia services in WLAN. To improve scalability and manageability for the quality of service (QoS) guaranteed wireless LAN (WLAN) access point (AP) using a simple mechanism. The IEEE 802.11e standard can be used as QoS-guarantee technology in the existing WLAN communication. Thus, a large number of enhancements to the standard are being proposed.**

Keywords-IEEE 802.11, Contention free period, QoS.

1.INTRODUCTION

Nowadays, the use of WLANs is on the increase mainly due to their low cost, their ease of deployment and, above all, by allowing the end users to freely move around within the area they cover [1]. Another influential factor is the appearance in 1997 of the standard IEEE 802.11, with its subsequent revision in 1999, and its subsequent amendments that nowadays enables transmission speeds of up to 54 Mbps. The basic access function in IEEE 802.11 is the *Distributed Coordination Function* (DCF) where before transmitting, a station, the source station, must determine the state of the channel. If during an interval of time, called *Distributed InterFrame Space* (DIFS), the channel is sensed free, the station can initiate its transmission. If the channel is sensed busy, once the transmission in progress is finished and to avoid the collision with other stations in the same situation, a back off algorithm is initiated. This algorithm consists in choosing an interval of time (the *backoff time)* at random during which the station delays the transmission of its frames. Once having transmitted the source station, it will wait to get back a time interval, denominated *Short Interface Space* (SIFS<DIFS), the source station does not get the *Immediate Positive Acknowledgement* (ACK) from the destination station, it simply assumes that there has been a collision. The source station can then attempt to retransmit a finite number of times using a longer back off time after each attempt. This access function is easy to implement and suitable for most applications. However, it does not provide Quality of Service (QoS) support. As an alternative but optional solution the *Point Coordination Function* (PCF) can in turn he used. It is a centralized access method where a node, the *Point Coordinator* (PC), will poll in turn each one of the stations allowing them to transmit without having them to compete with each other in order to gain access to the channel. This method is only used during *Contention Free Periods* (CFP) started at regular intervals by the PC. The PCF mode has been designed to give QoS support but it is limited by the polling scheme being used [3] and by the fact that the beginning of the CFPs is random. This randomness can delay the transmissions from the polled stations adding an extra access delay [4]. The above open issues have led many researchers to design techniques to provide solutions for both operation modes, DCF and PCF, using traffic engineering principles [5], with the objective of making a better use of the network resources. In this work, we overviewed and classified a large number of the proposed techniques. We also review the ongoing efforts towards the definition of the IEEE 802.11e standard for wireless local networks with QoS support.

2. QoS IN IEEE 802.11

Previous survey papers have presented a reduced number of QoS-aware techniques based on the IEEE 802.11 standard [6].Some other studies have only focused on the DCF technique [7]. Each technique is focused on modifying one of the coordination functions. First we distinguish between those techniques affecting the DCF and PCF. Various approaches have been used for both of them: the first approach is based on priorities, giving access preference to those stations that have been assigned higher priority. The second approach uses fair scheduling algorithms and shares the resources proportionally to a pre-assigned weight. Finally, a third approach (only in PCF) is based on maximizing the amount of flows whose QoS needs are covered.

2.1 QoS support for DCF

2.1.1 Priority-based.

In some techniques, the assignment of the priorities that allow preferential access to the channels is done by assigning different values to the parameters used to access the medium: the IFSS and the CWs. Due to the characteristics of the DCF, the shorter the IFS used, the earlier a flow will be able to start transmitting. However, a shorter CW translates into a shorter back off time. This is true in the schemes by where these assignments are for a finite number of priority classes. This is also used in the priority scheme where the assignment is done in a dynamic way to maximize the throughput of the system. Cben et al. In [12] shows the Priority-based Contention Control (PCC) scheme where the calculation of the CW depends on the Priority Limit (PL) (sent in each transmission) which is the value used to forbid the access to the channel by those stations with less priority. This is the case of the TCMA (Tiered Contention Multiple Access) protocol and one of the schemes .The latter also introduced a differentiation mechanism based on the frame sizes. It is worth pointing out one of their studies which shows that the use of TCP traffic decreases the difference between the priority types. That is the main reason why they suggest using flow rather than station based mechanisms. This is the case of algorithms Virtual MAC and Virtual Source (VMAC and VS) that emulate the operation of the MAC and application layers in order to obtain reliable statistics for all types of QoS measures, used by an admission control mechanism. On the other hand, the DBASE (Distributed Bandwidth allocation Sharing Extension) protocol uses different IFS for asynchronous and real time traffic where the former must use DCF and the latter can keep, share and free the resources in a dynamic way. Regarding the DCF + DCF/SC scheme, the higher priority traffic uses the Distributed Coordination Function with Short Contention-window (DCFBC), with a smaller CW and a time SIFS/DIFS. Finally an algorithm of admission control, the Connection Admission Control (CAC) that bases its decisions on the available resources. Another way to establish priorities consists in substituting the backoff algorithm by the transmission of a jamming signal. In this case, since a station has to be inactive when it detects a signal in the channel, that which produces a longer-length jamming signal is assured of getting the channel. In [21] a process is added to this scheme to maximize the amount of data to be sent per frame, and a chaining mechanism is also added to invite stations to transmit so that the waiting time is shortened between two consecutive transmissions.

2.1.2 Fair Scheduling-based.

The schemes which are based on the assignment of priorities do not work well if the number of stations is large. The solution consists of using fair scheduling algorithms. In these cases well known algorithms which have given good results applied to their equivalent wired networks are usually used. The Distributed Fair Scheduling (DFS) algorithm integrates within DCF the Self Clocked Fair Queuing (SCFQ) algorithm which selects a frame to transmit and uses a mapping scheme to calculate the back off time proportional to its size and to the assigned weight. The Distributed Deficit Round Robin scheme eliminates the back off time and is based on a Deficit Round Robin (DDR) algorithm which assigns an FS proportional to the Deficit Counter (DC) whose magnitude is employed to obtain permission to send frames. And the Priority Based Fair MAC protocol (P-MAC) adjusts the CWs so that each station starts transmitting at the optimum time thus minimizing collisions. The last technique in this section is a special case because it uses, depending on the type of traffic involved in transmission, a priority scheme based on the jamming or on the Distributed Weight Fair Queuing (DWFQ) algorithm which assigns dynamically a CW based on a variable consistent with the traffic transmitted and with the weight assigned and which must be same for all.

2.2 QoS support for PCF

It is possible that by making the use of PCF optional has had an influence in that the majority of the proposals have been for DCF. The principal objective of the techniques for PCF is to obtain the polling mechanism which meets the QoS needs of traffic.

2.2.1 Priority-based. The Adaptive Polling Algorithm is based on assigning higher priority *to* those stations which have responded to polling more times, calculated with the help of the Additive Increase/Multiplicative Decrease (AIMD) logarithm. The Contention Period Multi poll (CP-Multi poll) mechanism aspires to incorporate the DCF access scheme into the planning of polling in PCF. The idea is that the PC can periodically poll various stations at the same time assigning each of them different back off times, that being less for higher priority stations.

2.2.2 Fair Scheduling-based

. In the Distributed Deficit Round Robin (DDRR) the PC should use polling based on the Deficit Round Robin algorithm. The stations which the PC polls must have a positive Deficit Counter (DC) which increases according to the weight assigned. Another scheme is that which applies an admission control which respects the maximum delays of the real time traffic (using the Earliest Due Date algorithm - EDD) and the needs of throughput of the non-real time traffic. The planning schemes aim at maximizing the system’s transmission rate minimizing the rate of discard. In the EOG scheme is presented which gives priority first to those stations with frames which are about to be discarded (as in Earliest

Due Date - EDD) and then to those which have had the highest discard rate (as in Greatest Loss first - GLF). The same authors also present another scheme called Lagging Flow First (LFF) which favours the transmission of those frames which belonging to a given flow with a discard rate above the admission rate.

2.2.3 Per station maximum QoS achieving-based.

It is suggested that fairness is not necessarily the best solution. Better results can be obtained by trying to maximize the number of stations whose QoS needs are covered sacrificing only a minimum number of the stations. Ranasinghe et al. in [10] present two alternatives. In the first called Embedded Round Robin (ERR), the PC maintains two polling lists, one with those stations which have frames for sending and the other with those that do not have. In each turn all those from the first list can transmit and only one from the second is polled so that it can inform as to whether or not it now has any frame to transmit. When there is congestion this scheme does not work well. As a solution they offer this second technique, the Wireless Dual Queue (WDQ), which adds the Dual Queue (DQ) algorithm to the ERR and consists in temporarily setting aside those station which load the network at times of congestion. In third technique is presented called Least-Recently-Used ERR (LRU-ERR), also based on the ERR scheme, which limits the introduction of stations in the first list when there is congestion.

3. Problems in Existing WLAN QoS mechanisms

The IEEE 802.11 standard committee is now drafting a new standard called 802.1 le to achieve the QoS-guaranteed communication. The legacy WLAN has two kinds of access control functions at the medium access control (MAC) layer: the contention-based distributed coordination function (DCF) is a mandatory function and the point coordination function (PCF) is an optimal function. In the 802.1 le standard, the legacy DCF/PCF must be replaced by HCF which is a new access medium access function to achieve QoS-guaranteed communication. HCF is a mandatory function in all 802.1le supported APs. This 802.1le standard has two main kinds of the QoS-guarantee methods: EDCA was designed as a priority-based access control like a Diffserv protocol and HCCA was designed as a parameter based access control like an Intserv protocol. This section describes these two methods and clarifies their problems when they are applied to public WLAN access environments.

3.1. EDCA

In the WLAN, the wireless channel is fairly shared by all terminals accessing the same AP, so some access control methods are needed. APs of legacy WLAN support the CSMA/CA protocol, which is based on a round-robin algorithm to execute access control. However, this method has some problems in providing QoS guaranteed communication, because it does not support the concept of differentiating frames with differential priority. Thus, the AP cannot execute frame transmission access control according to each terminal’s requirement, because access probabilities of all terminals are almost equal and the frame transmission interval becomes much the same among all terminals accessing the same AP independent of the terminal's requirements. To solve this problem, EDCA was designed to be a priority based priority based access control method based on the CSMA/CA protocol in the legacy WLAN.

3.1.1. Mechanism of EDCA

In this method, the QoS priority class is negotiated between the QoS-requesting terminal and the corresponding AP before communication start up. This QoS priority class is called the access category (AC). There are four kinds of priority classes’ voice, video, best effort, and background. This negotiated AC value is registered in the frame classification part of AP. It is embedded in every MAC header by the AP in the downlink communication, and by terminal in the uplink communication, respectively .In the downlink communication, the AP recognizes the terminal identifier information from MAC header of the received frame and retrieves the corresponding information from the frame classification part. These frames are classified into a suitable frame transmission queue according to four the AC value. This priority-based QoS communication can be achieved by varying the frame transmission interval according to the AC value. Thus, a high AC value is set to get a short frame transmission interval, so the frame transmission queue that is set for a high AC value can ensure that frames are sent preferentially. In the uplink communication, the AP can control the allocated communication time of the wireless channel. The AP can retrieve the mapping information from the frame classification part as well as the downlink communication, and a high AC value is set to get a short frame transmission interval. So the frame transmission queue with a high AC value gets a short waiting time for sending frames and this frame transmission queue can ensure that communication frames are sent preferentially.

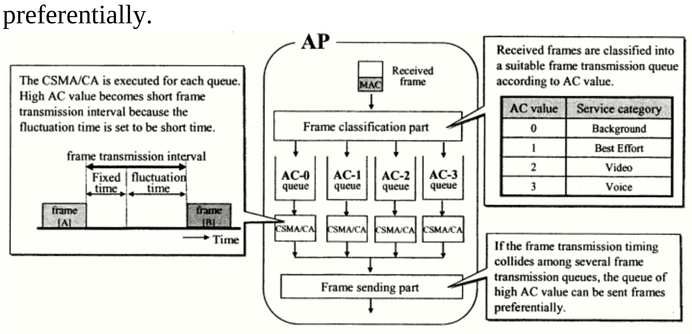

Figure 1. Mechanism of EDCA.

3.1.2. Problem with EDCA

The throughput of each terminal can be calculated from the amount of sent/received frames per unit of time (i.e., "frame size" x "number of frame"). Thus, if the numbers of terminals with high QoS priority increases, the frames transmission queue with a high AC value has a relatively longer waiting time for sending frames. Therefore, the allocated communication time of the wireless channel is not sufficient to guarantee the QoS communication for the requesting terminals. The amount of sent/received frames per unit of time decreases, and the throughput of each terminal decreased. In public WLAN access environments, all users can use an unspecified number of APs to achieve the AP roaming, so the number of terminals accessing an AP varies over the time scale of hours to days. Therefore, we think that it is difficult for this method to guarantee QoS communication very well in public WLAN access environments.

3.2. HCCA

The HCCA is a parameter-based access control method that can control the allocated communication time of wireless channel to negotiate some QoS parameters between the QoS-requesting terminal and the corresponding AP.

3.2.1. Mechanism of HCCA

In this method, some QoS parameters are negotiated between the QoS-requesting terminal and the corresponding AP before communication start up. They QoS include the terminal's QoS requirements (e.g., throughput and delay). After this negotiation procedure, a frame transmission queue is set up for each QoS-requesting terminal. In the downlink communication, the AP recognizes a terminal identifier from MAC header of the received frame, and retrieves the corresponding information from the frame classification part. These frames are classified into a suitable frame transmission queue that has already been set up for the QoS-requesting terminal. The AP can control the allocated communication time of the wireless channel, it can manage the frame sending schedules of each frame transmission queue that sends communication frames to satisfy the negotiated QoS requirements per terminal. In the uplink communication, the AP also executes the same procedures as in the uplink communication. However, the number of frame transmission queues have some limitations in the existing HCCA (i.e., the number of maximum queues are eight), because this method has been mainly designed for the communication between home electronic appliances with WLAN functions. Therefore, the maximum number of QoS-guaranteed terminals for each AP is equivalent to the maximum number of frame transmission queues. So this method has a critical problem on scalability viewpoint in the public WLAN access environments.

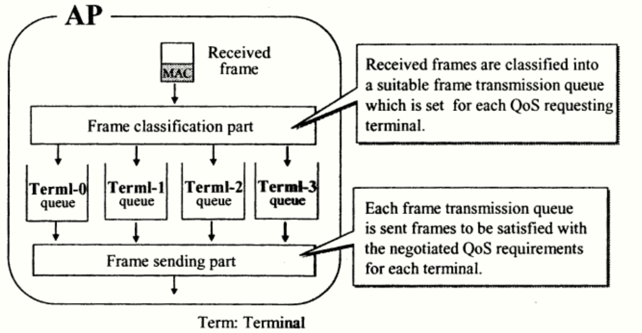

Figure 2. Mechanism of HCCA.

3.2.2. Problems with HCCA

In this method, the AP can control the amount of allocated communication time of wireless channel per terminal, so this method needs a frame transmission queue per terminal to manage frame transmission interval. However, the number of frame transmission queues have some limitations in the existing HCCA (i.e., the number of maximum queues are eight), because this method has been mainly designed for the communication between home electronic appliances with WLAN functions. Therefore, the maximum number of QoS-guaranteed terminals for each AP is equivalent to the maximum number of frame transmission queues. So this method has a critical problem on scalability viewpoint in the public WLAN access environments in which it is very difficult to expect the number of access terminals in advance.

4. Proposed frame queuing algorithm

We propose a simple frame queuing algorithm that takes into account the features of both WLAN and the service applications. When applied to 802.1le standard of the HCCA method, this algorithm can reduce the number of frame transmission queues, and make the frame transmission scheduling management easier.

4.1 Relationship between frame transmission time and frame size

Table 1 shows calculated frame transmission times for different frame sizes and different physical data speeds using an 802.11 a WLAN. This calculation used the parameters shown in table 2 [5], [6].

Table1. Relationship between physical data speed and frame transmission time.

Physical data speed / Frame Size	6Mbps	18Mbps	36Mbps	54Mbps
600Bytes	241µs	185µs	175µs	169µs
1,500Bytes	2,125µs	789µs	457µs	349µs

Table 2. 802.11a WLAN Parameters.

AIFS	SIFS	Slot Time	CW (Max/Min)	Error Rate
2	18µs	9µs	7/7	5%

These results show the frame transmission time is strongly influenced by a large frame size. Since, the frame size of VoIP is relatively small (i.e., 50-80 bytes when a G.729 codec is used), so these frame transmission time of VoIP is hardly influenced by the differences in physical data speed. On the other hand, the frame size of video streaming is relatively large (i.e.800-1500 bytes), so the frame transmission time of video streaming communication is strongly influenced by the differences in physical data speed.

4.2. QoS-guarantee method using the proposed the frame queuing algorithm

In this method, the frame classification part checks MAC header from the received frame and executes the proposed frame queuing to meet the contracted QoS requirements. The proposed frame queuing algorithm is based on the existing HCCA method, and it considers for the physical data speeds and service application as follows. The frame classification part can recognize the service application from MAC header of the received frame. If the service application is VoIP, the physical data speed is set to the lowest speed independent of the distance between the AP and terminal, because the frame transmission time of VoIP is hardly influenced by differences in physical data speed as explained. Therefore, the frame transmission queue does are not need except for the minimum physical data speed, so the number of frame transmission queues can be reduced to one. On the other hand, if the frame classification part recognizes video streaming from the MAC header of the received frame, the physical data speed is set to a suitable speed for the distance between the AP and terminal, because the frame transmission time of video streaming is strongly influenced by differences in physical data speed. Frame transmission queues are set up for each physical data speeds, so the AP can keep a constant frame transmission interval from the same frame transmission queue and frame transmission scheduling management is easier.

5. Conclusion

In this paper, we proposed a frame queuing algorithm considering both WLAN's physical data speed and frame size of service application, and applied it to the existing HCCA of the 802.1le standard. This can provide high scalability and easy manageability in a public WLAN access environment.

REFERENCES

[1] IEEE STD 802.1le/Draft 10.0 "Medium Access Control (MAC) Enhancements for Quality of Service (QoS), November 2004.

[2] P.Garg, etc, "Using IEEE 802.1l e MAC for QoS over Wireless", IPCCC'03, 2003.

[3] S.Mangold, etc, "Analysis of IEEE 802.11 for QoS Support in Wireless LANs. In IEEE Wireless Communications, Vol. 10, pp. 2-12, December 2003.

[4] IEEE STD 802.11 a "Partl 1: Wireless LAN Medium Access Control (MAC) and Physical layer (PHY) specifications High-speed Physical Layer in the 5 GHz Band", 2000. [5] M.Gast, "802.11 Wireless Networks: The Definitive Guide", O'Reilly, 2002.

[6] S.Mangold, etc, "IEEE 802.1 le Wireless LAN for Quality of service", the European Wireless, Vol. 1, pp. 32-39, Florence, Italy, February 2002.

[7] W.T. Chen, Y.M. Lin and S.C. Lo, "Priority-Based Contention Control in IEEE 802.11 Wireless LANs", 16th International Workshop on Communications Quality & Reliability (CQR 2002), Okinawa, Japan, May 2002.

[8] Y. Xiao, "A Simple and Effective Priority Scheme for IEEE 802.1 l", IEEE Communications Letters, vol. 7, num. 2, pp. 70-72, February 2003

[9] A. Veres,A.T. Campbell, M. Bany, and L.H. Sun, "Supporting Service Differentiation in Wireless Packet Networks Using Distributed Control", IEEE Journal of Selected Areas in Communicate-lions (JSAC). Special Issue on Mobility and Resource Management in Next-Generation Wireless Systems, vol. 19, num. IO, pp. 2094-2104, October 2001

[10] M. Barry, A.T. Campbell, and A. Veres, "Distributed Control Algorithms for Service Differentiation in Wireless Packet Networks 'I, Proc. IEEE INFOCOicp2001, vol. 1, pp. 582 -590,

[11] S.T. Sheu and T.F. Sheu, "A Bandwidth AllocatiodSharingl Extension Protocol for Multimedia over IEEE 802.11 Ad Hoc Wireless LANs", IEEE Journal on Selected Areas in Communications, vol. 19, num. 10, pp. 2065-2081, October 2001.

[I2] K. Kim, S. Shin and K. Kim, "A novel MAC scheme for prioritized services in IEEE 802.1 la wireless LAN", Proc. ATM (ICATM 2001) and High Speed Intelligent Internet Symposium Joint 4th IEEE International Conference, pp.196-199, April 2001

[13] W.T. Chen, 1.J. Dai and S.C. Lo, "A MAC Protocol with QoS Guarantees for Multiclass Traffics in Wireless LANs".

