# Dynamic Dropped packet regulation of contention window for enhancement of IEEE_802.11e

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## Abstract

*In this paper we present a new scheme which is mend to increase efficacy of present EDCA and also to make EDCA robust in high noise environment where high packet loss is characteristic. Next section of this paper provides an account of EDCA mode. Further it also informs about limitations of present EDCA scheme. Later section of paper presents the proposed scheme. Newly proposed scheme exploits known facts which are presented in previous standards, journals or other kind of research articles. The main objective of the paper is to propose a new scheme DDPA (Dynamic dropped packet algorithm.*

## Keywords

*EDCA, QOS, IEEE_802.11e, WLAN*

## 1. Introduction

QoS (quality of service) is an important aspect of data transmission. IEEE 802.11e defines a scheme which is intended to regulate QoS in in WLAN [1]. Earlier DCF ( Distributed coordination function was not capable [2,3] of giving QoS services as exacted by different forms of application. Say a Voice data is considered to be more important than a particular background service, video data is important than best efforts, In this way data needs to prioritized according to its type. Earlier version of IEEE 802.11 was not committed to assist traffic from different stations on basis of types of their data. Several papers and other kind of research articles have been made presented before in this regard. In this paper we are proposing a new enhancement in EDCA which is expected to be superior than present EDCA scheme. This was done when DCF was found limited in terms of QoS. EDCA ( enhanced distributed channel access) was introduced in order to incorporate priority among different kind of traffic. With introduction of EDCA in WLAN stations (both APs and non APs) were modified at MAC (media access control) level. This scheme was compatible with stations fabricated to work with previous standards. Even after introduction of EDCA in IEEE 802.11 it was found further that this scheme too is not effectively optimum[3]. Number of research articles [2-5] has been published in this regard and many of these were innovative in their approach, though we found that these schemes

suffer in terms of practical scenarios where there is high packet drop rate. The ulterior reason for this flinch is that in many of approaches no consideration for dropped packets have been taken, in fact prior algorithms have been relied on CSMA/CA for this purpose. Since EDCA protocol is implemented at MAC level, hence any effort or amendment should avoid direct modification which could make present devices incompatible. In [3] author propose a "Dynamic user adaptive scheme" and along with that they have expounded problem of parallel access i.e. problem when stations with same access class (defined as per EDCA [1]) compete for channel. [3] also issue related to starvation of low priority traffic due to non optimized contention window expression.

## 2. The EDCA mode

In IEEE 802.11e every traffic kind reserves different queues on each station of WLAN. A particular traffic category corresponds to a CAF (channel access function). Every station can possess up-to 4 CAF. Usual CSMA/CA mechanism is followed by each of the CAF with every CAF having a different backoff process. Backoff counter of individual CAF decremented for one time slot when channel is sensed idle, while if transmission is sensed on channel backoff counter is stopped. When backoff counter reaches to zero value CAF generates frame over channel. AC (access category) group CAFs. Every CAF belonging to same AC shares same configuration.

Different frames make to different AC according to their traffic types. Four types are traffic is prioritized with help of "Access class specifies". Order of prioritization is as follows:
Voice traffic >> Video >> Best efforts>> Background services
As such one can say AC_VI, AC_VO, AC_BE, AC_BK corresponds to Voice, Video, Best efforts and Background services respectively. AIFS corresponding to each AC would following inverse order i.e. AIFS of voice traffic would be smaller than AIFS of video, Similarly AIFS of video would be smaller than AIFS of best efforts and AIFS of best efforts would be smaller than AIFS of background services. Another parameter which is associated with AC is contention window. Contention window is initially set tp $CW_{min}$ and is allowed up-to value of $CW_{max}$ . There actually two counters already present

in each STA (station), among which one is SSRC ( station short retry counter) and other is SLRC ( station long retry counter). Both of these counters are updated with respect to kind of retry (long or short) of MSDU (MAC service data unit) by station. Any event related to update of these counters actually reflects in size of CW i.e CW is increased. CW is updated as per the following relation.

$$CW_{new} = 2CW_{prev} + 1$$

for example,

if $CW_{min}$ is 7 i.e actually $CW_{prev}$ (initially),

then $CW_{new} = 2x7 + 1 = 15$

Similarly next would $CW_{new}$ would be 31, further this series could be 63, 127 , 255 ( $CW_{max}$). Figure 1 shows CW series starting from $CW_{min}$ to $CW_{max}$.
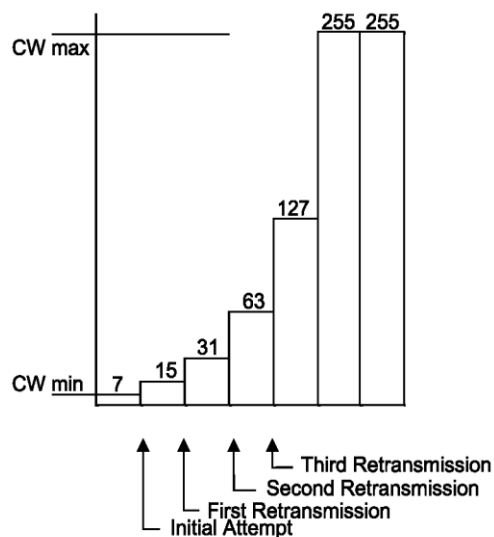


**Figure 1: CW series starting from $CW_{min}$ to $CW_{max}$.**

## 3. Limitations of original EDCA

Original EDCA suffered from number of flinches. First and the foremost flinch that has been known issue is low throughput of EDCA. Even though many research ideas were previously provided but either they were contingent on number of active [3] station or they were heuristic in approach [6, 7]. Thus even though these proposed algorithms were successful to an extent but they lacked solid analytical backgrounds.

**We found following major drawbacks in present EDCA:**
As in present EDCA traffic is prioritized only in four categories there always remains possibility of

collision of MSDUs when MSDUs of same AC are transmitted by different stations simultaneously on channel. This will certainly hinder in way of obtaining high throughput. This may arise to situation where one STA may dominate over other while transmitting same data belonging to same kind of AC. This will be spurious as it will be irrational for starving STA.

As currently EDCA algorithm is having no account of dependency on starving node ( this node may be starving due to any kind of generic dysfunction) thus there is no mean to privilege such node in terms of granting channel access. Due to this a suffering node may keep to suffer for undefined time Current EDCA algorithm is not able to adapt physical environment limitation i.e it is having no means to adapt itself according to variation in noise of ambiance. As such there is no mean to enhance throughput when it comes to high noise environment.

In present EDCA there are no means of providing time bound solutions to address low priority node even when there is no high priority traffic as low priority node have to wait for long delay due to "static AIFS assignments"[3].

[3] Explains a way to eradicate this issue but is heuristic in approach of optimizing contention window. Also algorithm presented there was dependent on number of active station. This is not desirable because solutions could not be applied in universal manner to different scenarios. [4] Proposes universal approach but is highly complex when it comes for praticle implementation. Involvement of control system may lead to unstable regime by just small deviations in GM (gain margin) and PM ( phase margin) of regime.

Ultimate objective of this paper is to introduce a new approach which is capable of handling presented limitation but should not compromise with simplicity of system and practical feasibility of it. Some works may look successful on basis of simulations. But simulations may not work in practical environments as there is as to handle such situation there must be some inbuilt flexibility to adapt according to ambiance. Our DDPA algorithm is totally based on dropped packets as such this algorithm have inbuilt tendency to detect noise ambiance and further act accordingly.

## 4. Proposed Algorithm

Our algorithm is exploiting number of facts which are characteristic of present EDCA algorithm which we have already announced in "Introduction" section. In order to improve the throughput flaw (source of

packet loss) is to be determined.  According to our algorithm each non-AP STA should possess a combination of a counter and timer. Whenever there is a packet loss i.e increment of SLRC or SSRC then our counter will be incremented (from initial value of zero). Let this new counter be termed as LC (loss counter). Let 'x' be variable associated with LC. Along with that each station will also possess a delay timer (DT). This timer is initiated with zero value and determines number of time slot for which a particular STA have accessed channel. Let 'y' be variable associated with this delay timer.

We have introduced these two variables in order to define Loss Function $F_L(x,y)$. x in loss function measures loss of MSDUs and y is a regulatory parameter. 'y' limits starving node from disturbing whole regime in case there is serious problem related with particular STA.
Now,

$$F_L(x,y) = x(1-K_1) \qquad ...............(1)$$

that is loss function is in direct relation with x. $K_1$ is integer constant which is related to y as following

$$K_1 = fy \qquad ................(2)$$

f is fractional constant such that $0<f<1$ which is dependent on scenario concerned. Now to understand the limiting action of (2) consider when value of fy is very small smaller than 1, in this case from (1)

$$\therefore \cong \cdot \quad .....(3)$$

this is because $K_1$  would be very smaller in comparison to  1. Consider another case when fy approaches to 1 this case $F_L$ tends to zero. This will occur in case of high amount of delays. Thus, it is seen that y is having capability to limit $F_L$ when there is high delay at station.

Clearly, Loss function is estimation of amount of starvation a node is suffering at real time. Also it is having a limiting variable which is responsible for checking high delays. Contention window will be manipulated according to $F_L$. To attain this new expression of CW is given by,

$$W_{new}[AC] = 2(CW_{prev}[AC] - F_L) + 1 ...................(3)$$

Comparing to this to original EDCA expression (4) we find that our expression is dependent dynamically on dropped packet,

$$CW_{new}[AC] = 2CW_{prev}[AC] + 1 ...................(4)$$

CW defined by (4) will eradicate major problems associated with original EDCA in following ways:
- When regime will be in high noise environment there would be high loss of

packets in data transmission of nodes. If ambiance is not uniformly noisy then there will exist variance in packet loss of different nodes. Our proposed regime in this case would be capable of privileging nodes with high loss, as it is clear from equation (3) nodes undergoing high loss will have smaller contention window.
- In case even after privileging starving node it is not capable of data transmission due to unknown reasons expression is capable of limiting further privileging of that node by evaluating 'y' in (2)
- Original EDCA was having no means to distinguish traffic when it comes to data transmission from same ACs. But after implementation of (3) regime would be able to differentiate between traffic from different stations on basis of their starvation. An important advantage of this system is that it provides privilege to node whenever it is detected that it is striving to hard for bandwidth. Thus no particular station can spuriously acquire channel for long time.
- 'f' parameter in expression (2) could be used to adjust system according to ambiance of regime.  A feedback system could be employed to regulate desired f with respect to dynamic ambiance of regime.

These merits of DDPA outperforms original EDCA to a great extend as such.

Our algorithm exploits following facts:
- The access point in WLAN is capable of manipulating contention window (CW) [1]
- Different timers and counters can be utilized in non Aps (access points) to determine properties of stations (STA)[7].
- Determined properties of these station can then be utilized to manipulate transmission parameters to enhance present EDCA regime.
- High noise environment are characterized by high loss of packets.
- We expect following advantages from our work
- New algorithm is robust in high noise environment because it is inherently adaptive to packet loss and is able to adjust regime as per the rate of packet loss.
- This algorithm is capable of handling parallel access problems and issues like starvation of low priority traffic due non optimized contention window.

# 5.  Conclusion

In this paper we present a new scheme which is mend to increase efficacy of present EDCA and also  to make EDCA robust in high noise environment where high packet loss is characteristic. Next section of this paper provides an account of EDCA mode. Further it also informs about limitations of present EDCA scheme. Later section of paper presents the proposed scheme. Newly proposed scheme exploits known facts which are presented in previous standards, journals or other kind of research articles. The main objective of the paper is to propose a new scheme DDPA (Dynamic dropped packet algorithm.

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