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A new method for classifying video packets in 802.11e based on deadline of packets

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ABSTRACT

Video over WLANs has been founded many applications today. These applications have special requirements and thus require particular handling in dealing with video content. 802.11e standard is a standard over WLANs which have a significant place in Quality of Service providing for multimedia applications. This standard uses Enhanced Distributed Channel Access mechanism which exploits 4 priority queues. In ordinary EDCA whole video frames are mapped to second priority queue. However for encountering variable condition of wireless network and also avoiding from inappropriate packet eliminating in EDCA queues some changes is required in EDCA queuing method. In this research proposed a new cross-layer approach for queuing in EDCA called Deadline-base Adaptation Mapping Algorithm. In this approach mapping of video frames to priority queues is according to frames content and deadline of each frame. This helps to more effective mapping for improvement of transmitted video quality. The cross-layer adaptation is performed via a proposed formula with relevant parameters. Simulation results show with exploiting right setting for DAMA mechanism parameters, receipted video quality has been improved at least 6 percent. This mechanism also has high flexibility and performance increment capability and ability of improvement in future.

Keywords: Video applications; Cross-layer approaches; EDCA mechanism; Packet classification; Deadline base mapping, DAMA.

Abbreviations: WLAN - Wireless Local Area Network; QoS-Quality of Service; EDCA - Enhanced Distributed Channel Access; DAMA - Deadline-base Adaptation Mapping Algorithm; CAR - Content-aware Adaptive Retry; TAR - Time-based Adaptive Retry; CA - RLA - Content Aware Retry Limit Adaptation; RED - Random Early Detection; GoP - Group of Pictures; WTT - Weighted Transfer Time.

1. INTRIODUCTION

Video transmission has been founded many uses in last years. In according to special condition of wireless environment and lack of stability in such channels, transmission of video over these environments is encountered great challenges and problems. For decreasing problems caused by wireless channel solutions have been taught. One of the most important of these solutions is 802.11e standard and EDCA mechanism on it. Among effective issues in 802.11e standard and particularly EDCA mechanism for video transmission, one is queuing the packets and how to mapping them. This issue doesn't be considered in standard as well. Unfortunately in last few years performed a little works on it too so now there is no strong algorithm can do mapping operation effectively and according to important parameter as deadline of video packets. Algorithms have been raised in this context either perform mapping operation as static or only consider queue length beside packets importance. While in addition to these two factors it requires to notice to factors such as speed of packets transmission from different queues and deadline of each packet which play an important role in video applications. Among the earlier works Ksentini and co-workers (2006) offer a method which classify video packets according to their importance constantly and instead of be putted all of video content on one queue which usually in EDCA mechanism is second queue, distribute them on different queues and therefore prevent from overloading intermediate queues or same buffer while video traffic congestion. This static method has been proposed over H.264 video coding but also can be used with little changes in the MPEG encoding. Also in this paper has been proposed Retry Limit for different queues be different to increase chance of reaching more important packets to receiver. This approach has been reviewed in Chilamkurti et al., (2010) and Cheng-Han et al., (2009) so researchers have been suggested putting video packets in lower priority queues be performed dynamically and only according to buffer queues length beside video packet content and one probability formula which is seen in Random Early Detection (RED) algorithm too. Thus unnecessary delay which usually is caused by mapping video packets to low priority queues be prevented. As a result of this approach, First filling buffer queues due to video traffic congestion be delayed and, Second, occurrence of delay in video packet transmission be prevented as possible. In Chilamkurti et al., (2010) queuing algorithm only is performed on second priority queue but in Cheng-Han et al., (2009) this algorithm is performed on lower priority queues too.

Algorithms mentioned ever, were related to classifying and queuing video packets in 802.11e standard. Other type of algorithms which point to them is useful, algorithms are that deal with retransmission of packets. These algorithms consider to concept namely deadline for decision which be mentioned here due to near relation with deadline concept using in this paper. In Mei-Hsuan et al., (2005) Content-aware Adaptive Retry (CAR) has been proposed which by using concepts proposed in Ergen and Varaiya (2005) is tried to prevent from retransmission of packets arrive in receiver with great delay and receiver can't play them. This mechanism which designed for 802.11 wireless networks, by elimination useless packets, makes condition appropriate for on-time transmission of next video packets. Since in this mechanism is notice to video frames importance and their dependencies together, thus packets with higher importance find more chance for retransmission and this make rather great upgrade in receipt video by receiver specially in bad channel condition and high packet loss. Same algorithm has again been proposed again in Mei-Hsuan et al., (2007) called Time-based Adaptive Retry algorithm however paper authors have tried to complete their work and survey it from other aspects too. In TAR is tried retransmission times of each packet be calculated in two conditions noise existence and without noise in a separately form and therefore be showed usability of exploiting TAR mechanism which do dynamically adaptation operation. In an algorithm called Content Aware Retry Limit Adaptation proposed in Chih-Ming et al., (2010), has been tried to provide more effective mechanism for retransmission of packets by using results of prior works and exploiting more precise analysis for give priority to packets. In this research is said according to estimation of next retransmission time, can identify delayed packets before making decision for transmission and indeed delete them one hop earlier. Length-based mechanism rather than prior mechanisms proposed has more complexity which makes its implementation difficult largely. This paper has uses from real play out delay which exploited at receiver side too.

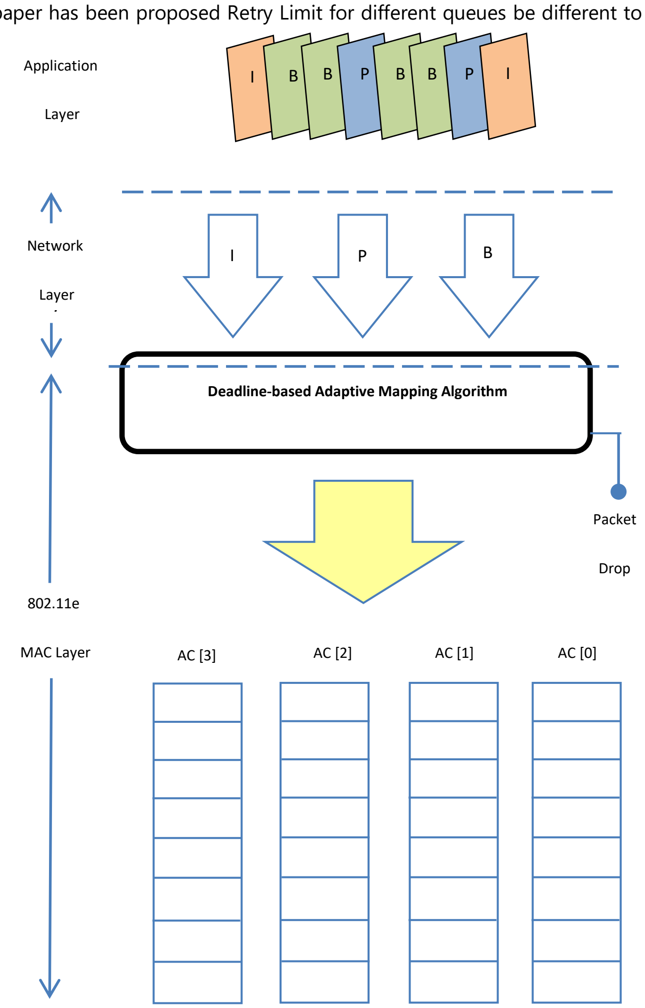

Figure 1
A general scheme from proposed mechanism

2. MATERIALS AND METHODS

As mentioned before, the main goal of proposed mechanism is effective queuing of video packets in EDCA mechanism. This proposed mechanism like other mechanisms discussed in prior section, operate in Data-link layer and must be used before mapping packets into different queues in EDCA. General scheme of this mechanism is observed in Fig.1.

2.1. General goals and algorithm

Before addressing packets mapping adaptation, it is better to are expressed algorithm objectives for greater perception of mentioned parameters and their relationship is created for forming an effective formula and finally an efficient mechanism.

- Adaptive mapping based-on deadline algorithm objectives
  1. Video traffic distribute between queues somewhat till second priority queue don't immediately fill
  2. Each packet be receipt on its deadline
  3. Packets have more importance arrive at destination with more guarantee

Following DAMA algorithm has been expressed which show overall procedure of mapping different packets into different queues.

Table 1 Simulation parameters values

Parameter	Value (Values)
Transmitting video	foreman-qcif
Video rate	30fps
GoP size	9
Video packets size	Up to 1024
Receiver playout delay	500ms
Retry limit	3 in two higher priority queues/1 in two lower priority queues
Transmission rate	Base rate 1Mbps/Maximum rate 11Mbps
Sender queues capacity	Each queue 50 packets
Queue size control algorithm	Drop-tail
Receiver buffer capacity	500 packets
*QWp*1[1], *QWp*1[2], *QWp*1[3]*	8,9.5,10
*QWp*2[1], *QWp*2[2], *QWp*2[3]*	7.5,7,6.5
*fraction_sum**	10,10
*x**	7

*Last four lines are related to proposed mechanism parameters. The first and second lines show weight of different queues in the first and second scan respectively and the third line shows the values of the first and second scan normalization. Also *x* parameter in end line is the value is used in *AQMET* calculation for weighting average values against current values.

Compute ($WTT(AC[2], P_{i,j}^{(k)})$)

if ($(WTT(AC[2], P_{i,j}^{(k)}) + T_{cur} - T_{start}) < D(P_{i,j}^{(k)})$)

$P_{i,j}^{(k)} \longrightarrow AC[2]$

else

Compute ($WTT(AC[1], P_{i,j}^{(k)})$)

if ($(WTT(AC[1], P_{i,j}^{(k)}) + T_{cur} - T_{start}) < D(P_{i,j}^{(k)})$)

$P_{i,j}^{(k)} \longrightarrow AC[1]$

else

Compute ($WTT(AC[0], P_{i,j}^{(k)})$)

if ($(WTT(AC[0], P_{i,j}^{(k)}) + T_{cur} - T_{start}) < D(P_{i,j}^{(k)})$)

$P_{i,j}^{(k)} \longrightarrow AC[0]$

else

Drop $P_{i,j}^{(k)}$

Table 2 Precise number of video frames in simulation

Total	B	P	I	Frame type / Parameter
400	266	89	45	Frame number
659	273	149	237	Packet number

2.2. Parameters and formulas

This algorithm has following parameters:

- $WTT(AC[QN], P_{i,j}^{(k)})$: weighted transmission time for packet $P_{i,j}^{(k)}$ in queue $AC[QN]$
- T_{cur}: current time
- *Tstart*: time of video streaming start
- $D(P_{i,j}^{(k)})$: packet $P_{i,j}^{(k)}$ deadline according to maximum playout delay in receiver
- *QN*: queue number

It is noteworthy in $P_{i,j}^{(k)}$, *i* showing the packet GoP number, *j* showing frame packet number and finally *k* showing packet number in frame.

In this algorithm $T_{cur} - T_{start}$ expressed how time past from video stream. $D(P_{i,j}^{(k)})$ is calculated according to [4] and the only difference with [4] is it use from real playout delay instead computational playout delay. Its calculation formula is:

$D(P_{i,j}^{(k)})=\Delta+((i-1)\alpha+(j-1))\lambda+R(P_{i,j}^{(k)})$ (1)

- Δ: maximum playout delay in receiver
- α: GoP size
- λ: inter-frame interval
- R: extended period according to packets importance

Also $R(P_{i,j}^{(k)})= \lambda(M(F_{i,j})+1)$ (2)

$M(F_{i,j})$: number of frames inter-coded with respect to $F_{i,j}$ frame Parameters must be into consideration in queuing mechanism included following cases:

1. packet transmission time from a priority queue
2. given queue length according to number of packets
3. importance of packets
4. a special weighting coefficient for each queue

According to stated subjects proposed formula is expressed as;

$WTT(AC[QN], P_{i,j}^{(k)}) = AQMET(AC[QN]) \times Qlen(AC[QN]) \times ((QW(AC[QN]) + PICO[P_{i,j}^{(k)}]) / k)$ (3)

The formula parameters are:

- *AQMET:* average queue moving estimated time by packet
- *Qlen:* queue length by number of packets
- *QW*: the special weighting coefficient for the queue
- *PICO*: packet importance coefficient
- *k*: sum normalization parameter

The Weighted Transmission Time is parameter finally is used for decision. Therefore because the algorithm objectives are satisfied this amount must be calculated desirable.

2.3. New parameters description

Method of calculating and using these parameters for weighting transmission time estimation are following:

First parameter in *WTT* calculation which is our proposed factor for deciding, is parameter called *AQMET*. Indeed we want to know what time is spent for transmission a packet over network in a given queue approximately. Mean time for transmission each packet in the queue can be estimated according to first transmission time, current time and number of queue transmissions ever and assuming queue was empty no time (here *AQMET)*. If the queue be empty among progress, this time must be reduced from difference between transmission time and current time.

The next parameter namely *Qlen* is current queue length in terms of packet that by multiplying it by mean transmission time of each packet, about of packet transmission time is identified. *QW* parameter shows weight of different queue. Indeed each priority queue must own a weighting parameter (here called *QW(AC[QN])* by the goal which if a packet want go to lower queue or priority, packet deadline permit it. It means packet haven't been sent only while staying it in high priority queue has intense time limitation because then going packet to the low priority queue likely this time limitation even be more sever. As a result weight parameter must be more for higher priority queue which there be priority of going to lower priority queue. This arbitrary parameter can be decimal to providing better precise for deciding. For applying packets importance, is added *PICO* parameter to *WTT*. Indeed types of frames according to their importance must get a importance factor (here $PICO[P_{i,j}^{(k)}]$). Because this factor whatever be greater, end achieved number will be larger and will be closer to packet deadline, therefore more important packets must get smaller factor till probability of remaining them in high priority queue be further. In according to symbols was defined before, we consider this amount equal to $(\alpha - M(F_{i,j}))$ that provides this condition. Parameter k actually makes calculation normal and rational and by it can control how much additional estimating is needed.

2.4. Important matters

1. Although *PICO* parameter considered in other form in deadline calculations means other side of equation too but deploying it contemporaneous in both sides of equation cause impact of it become more from before and as a result probability of going packets of I frames to lower priority queues become low and therefore more important packets get good service.
2. The amounts of *QW* parameter must be selected so matched with *PICO* amounts. *PICO* amounts is selected from (1,α) range which α as mentioned before, is the GoP size. Then *QW* amounts of queues must get values close to this range until they be effective and also don't eliminate *PICO* effect. Also *k* values must be such which result of sum and division become greater than 1 and about close to it too. Since *AQMET* is an estimated value and in practice may be spent less time for packet transmission, result of sum and division can be less than 1 under some conditions because prevented from indiscriminate and unreasonable removal of packets.

Estimation for transmission of packets in this step is more than real transmission time on many times. This affair done for two reasons: 1-there is enough time for retransmission of packets, 2-entering packets to the next queues without encounter with intense time limitation is possible, 3. Deadline which is considered in this formula (i.e. *D*), must be closer to real deadline as possible till packets don't been

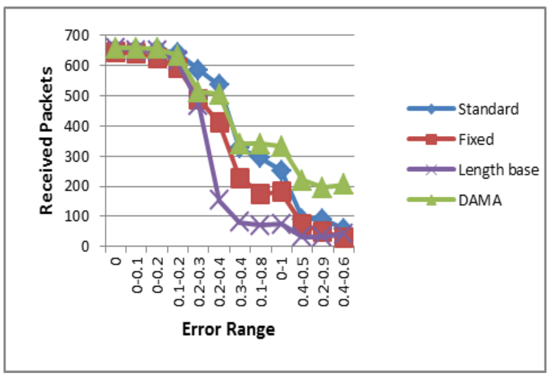

Figure 2
Number of received packets while streaming only two video

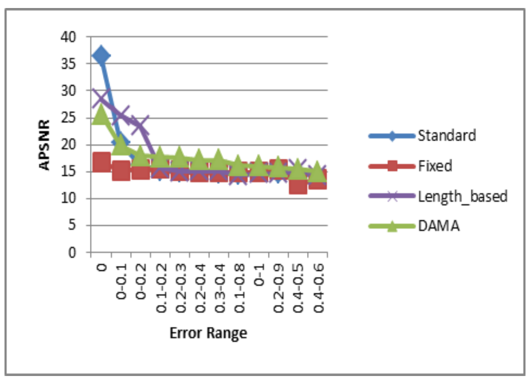

Figure 4
APSNR at receiver in normal traffic state

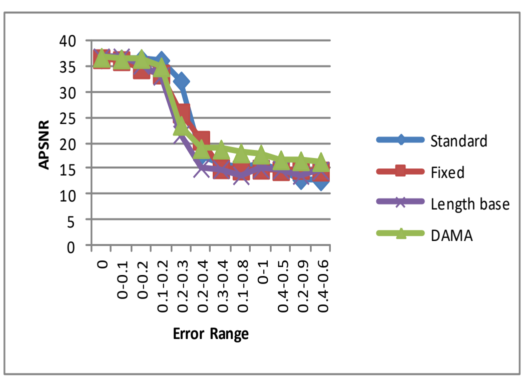

Figure 3
APSNR at receiver while streaming only two video

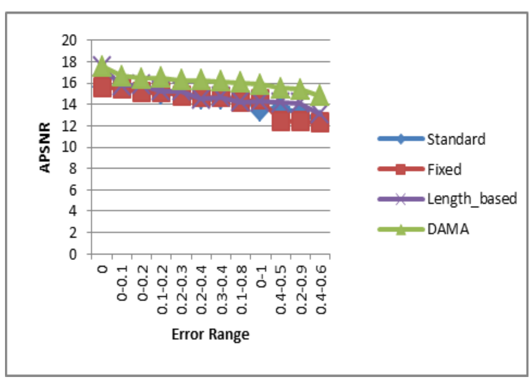

Figure 5
APSNR at receiver in heavy traffic state

eliminated indiscriminate and improperly. If sender guesses receiver's play out delay, this value can be used in deadline calculations in this section. In addition for restriction improperly removal of packets and its subsequent quality decline of transmission video as possible, that's better, another layer of algorithm with different values from before are performed called second scan. These values can be applied to each of parameters *k* or *QW* until prevent removes which could don't be done.

3. RESULTS AND DISCUSSION

For simulating proposed mechanism have been used from NS-2 and Evalvid tool, which is employed for transmission and evaluating video over NS. Evalvid drawback in context of video transmission is lack of video buffering and buffering management in the receiver side which troubled evaluation of proposed mechanism. So be added buffering ability and buffering management to Evalvid till researchers can do simulations and evaluations of videos related issues effectively in future works. Before simulation scenario expression, declaration of some assumptions and also values of different parameters is required.

Simulation assumptions:

1. Two nodes in the network are defined: 1- video sender or server, 2- video receiver or client.
2. Wireless part of network is considered.
3. Both nodes are fixed and motionless.
4. Video coding is MPEG-4.
5. Channel error follows from uniform distribution.

In Table 1 some important simulation parameters and in Table 2 precise numbers of video frames is observed. In simulation, we study proposed DAMA mechanism in 3 states: 1-only video traffic, 2-normal traffic and 3-heavy traffic. In these states is been compared two parameters number of received video packets by receiver and also average of PSNR (APSNR) via increasing network error. APSNR is a parameter which has many uses for measurement of video quality and acquires more precise estimation of video quality from PSNR. For abbreviation, trend of changing number of received video packets has been showed for video traffic state only (Fig.2). Charts have been acquired from 15 times simulation running (Fig.3).

In charts is shown proposed DAMA mechanism with stated setting, show better operation than other mechanisms in many times. Only in beginning of some charts (for example Fig.4) is observed while error is very low, operation of algorithm is weak. Reason is first, in these states with distribution of traffic on the other queues, some of packets have reached a little with delay rather than other mechanisms and second, due to estimation which have from packet transmission time some of packets be eliminated in the beginning but they shouldn't be eliminated. In other states these two mentioned cases haven't negative effect on algorithm operation. Because high density and approximately close operation of mechanisms in context of APSNR parameter, clarity of charts has been a little low but according to acquired results, quality improvement of video than other algorithms even reaches to 8db (for example Fig.5) while in many times is about 2db hence 6 percent approximately. Although for some states this benefit isn't very much and especially in more heavy traffics and in high error rate, received video quality in receiver won't reach satisfactory limitation but improvement of video quality can be beneficial even as low amount. It's mentionable with different setting of algorithm parameters can achieve better answers which more survey is needed. Also applying this mechanism together with a dynamic and intelligent retransmission method can increase its effect and even provide a favorite multimedia experience for users in very bad condition of network.

4. CONCLUSIONS

Multimedia applications usually required attention to time and deadline which makes different them from many of other applications. In this paper was introduced an approach for queuing video packets in 802.11e standard and EDCA mechanism based on deadline. Proposed mechanism called DAMA is a dynamic and adaptive cross-layer mechanism which considers several important parameters for queuing video packets. This mechanism with different configuration can achieved various answers on received video quality by receiver. Simulation with introduced setting in this paper, show about 6 percent improvement of video quality in rather bad condition for DAMA mechanism than prior queuing method.

SUMMARY OF RESEARCH

1. Video applications in a WLAN require special attention for quality improvement.
2. Fix Mapping in EDCA queues couldn't be effective for video streaming specially in variable channel condition.
3. In our study, a new mechanism called DAMA is proposed for queuing video packets in EDCA base on content and deadline of each packet.
4. In DAMA mechanism there is a new formula with some new parameters for deciding in queuing video packets.
5. Using DAMA mechanism can increase video quality specially in bad condition of wireless channel and when there are multiple flows.

DISCLOSURE STATEMENT

This work is an introduction for our main work which will be done in the future.

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