Cross Layer (Application and Medium Access Control) Design and Optimization of Wireless Network for Real Time Video Transmission

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Abstract- Robust streaming of video over 802.11 WLANs poses many challenges, including packets losses caused by network buffer overflow or link erasures, time-varying wireless channel and video content characteristics etc. To improve the performance of real-time video transmission over 802.11 WLANs, the use of cross layer design approach is required which allows communication between layers by permitting one layer to access the data of another layer, thereby facilitating the exchange of information. One of such design approach includes Application (APP) and Medium Access Control (MAC) layers considerations and is explored in this paper. This study focuses on H.264/MPEG4-AVC, the most widely accepted video coding standard and provides better quality compressed video and flexibility in compressing and transmitting video at APP layer and the retry limit settings of the MAC layer can be optimized in such a way that the overall packet losses are minimized. In this paper, the proposed Top-Down cross-layer design involves the mapping of H.264 video slices (packets) to appropriate access categories of IEEE 802.11e according to their information significance.

Index Terms- H.264/MPEG – 4 – AVC, IEEE 802.11, IEEE802.11e, IEEE 802.11 Timebase, AIFS, CW, Backoff counter, retransmission deadline, MAC-Centric cross layer architecture, .

I. Introduction

Video transport over wireless networks usually requires retransmissions to successfully deliver video data to a receiver in case of packet loss, leading to increased delay time for the data to arrive at the receiver side. Delay constraint is, one of the most important requirements in real-time applications [1]. To support the varying QoS requirements of emerging application such as those involving continuous media, a new standard IEEE 802.11 is specified. This standard aims to support QoS by providing differentiated classes of service at the MAC layer. The designing of cross-layer for video transmission over WLANs, it is necessary to study of APP layer and MAC layer characteristics along with the network behaviour. The main advantage of cross layering is to maintain the functionalities associated to the original layers but to allow coordination, interaction and joint optimization of protocols crossing different layers.

At APP layer, H.264/MPEG-4 AVC is a recent video compression standard jointly developed by the ITU-T VCEG and the ISO/IEC MPEG standard committees. This standard provides much higher compression than earlier standards. It allows not non-interlaced video coding but also interlaced video coding very efficiently, and also offers not only high-quality service in high-bandwidth network but also acceptable quality service in low-bandwidth network. Coding of video is performed by picture by picture. Each picture is first partitioned into a number of slices. Slice consists of sequences of macroblocks with each macroblock consisting of luminance (Y) and associated two chrominance (Cb and Cr). The hierarchy of video data as –

Picture[slice{macroblocks(sub-macroblock(blocks(pixels)))}]

IEEE 802.11e was proposed to prioritize packets into different categories for priority scheduling. The IEEE 802.11e EDCA is designed to enhance the 802.11 DCF mechanisms by providing a distributed access method that can support service differentiation among different classes of traffic aiming to better deliver multimedia traffic over the IEEE 802.11 WLANs. The EDCA of 802.11e standard defines four ACs. These four ACs which are proposed to carry four different types of traffic specifically voice, video, best effort and background traffic and have different transmission priorities as shown in Table I.

TABLE I Priority Value and corresponding AC's [2]

User Priority	Access Categories	Destination
3	AC_VO	Voice
2	AC_VI	Video
1	AC_BG	Best Effort
0	AC_BE	Background

In the framework Transport layer receive the slice type and deadline from APP layer and encapsulates it into packet header. MAC layer then retrieves the encapsulated information from the packet header as shown in Fig. 1.

Section II defines APP layer considerations, H.264/MPEG4-AVC video coding standard. Section III describes MAC layer considerations for real time video transmission. This evaluates the EDCA behaviour propose an appropriate video transmission techniques. Section IV introduce a proposed cross-layer design approaches to achieve optimized video transmission over WLANs. Section V discusses the conclusions of this work.

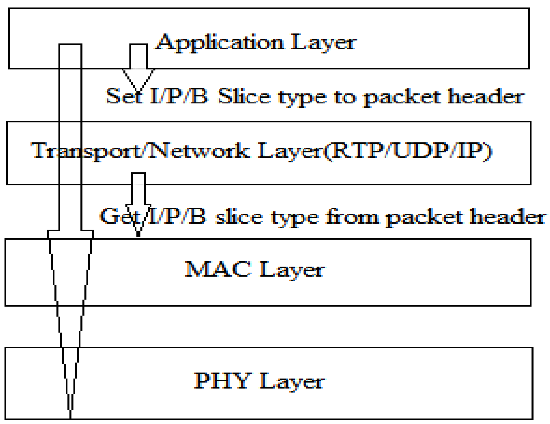

Fig. 1 Cross Layer Architecture [2]

II. APP LAYER CONSIDERATIONS

In WLANs, video applications can be classified into two different scenarios: real-time video transmission and video streaming [3].

The H.264/MPEG-4 AVC video codec used for video transmission over various networking environments also known as MPEG_4 Part 10 or MPEG-4 AVC. The different types of slices in H.264 include three basic slices are I slice, P slice, B slice and two derived slice type called SI- and SP-slice [4]. Typically, I-slices contain more video information and the coding reference frame for other frames (P and B frames) and Frame I - the first level of priority, Frame P - second level of priority and B frame belongs to the lowest level of priority.

Video coding solutions for APP layer are:

There are different video coding solutions for APP layer are: *The error resilience tools* are Slice structuring, FMO, Data partitioning and Error concealment, *RDO (Rate Distortion Model)* mode used for rate control in APP layer to adapt the video traffic to the network bandwidth. *JSCC (Joint Source and Channel Coding) schemes* attempt to develop APP layer solutions that consider both source coding rate as well as channel coding rate simultaneously. JSCC can efficiently utilize the UEP (Unequal Error Protection) algorithm to increase the transmission robustness of the video bit streams [3].

H.264/AVC video coding use two layers namely, VCL and the NAL [1]. VCL contains specifications of the video-encoding engine including motion compensation, transform coding of coefficients, quantization and entropy coding. Building Block of NAL are NAL units, parameter sets and access units. NAL is responsible for the encapsulation of the coded slices into transport entities of the network.

H.264/AVC achieves higher coding efficiency not only for progressive but also for interlaced video. It includes the concept of profiles [4].

Profiles:

The H.264/AVC standard defines subsets of coding tools intended for different classes of applications called Profiles. A decoder may choose to implement only one subset (profile) of tools.

1) The Baseline profile includes I- and P-slice coding, enhanced error resilience tools (flexible macroblock ordering (FMO), arbitrary slices and redundant slices), and CAVLC. It was designed for low delay applications, as well as for applications that run on platforms with low processing power and in high packet loss environment. Among the three profiles, it offers the least coding efficiency.

2) The Extended profile is a superset of the Baseline profile. Besides tools of the Baseline profile it includes B-, SP- and SI-slices, data partitioning, and interlace coding tools. It however does not include CABAC. It is thus more complex but also provides better coding efficiency. Its intended applications were streaming video.

3) The Main profile includes I-, P- and B-slices, interlace coding, CAVLC and CABAC. It shares common tools such as I- and P-slices, and CAVLC with both the Baseline and Extended profiles. In addition it shares B-slices and interlaced coding tools with the Extended-profile. The Main profile was designed to provide the highest possible coding efficiency.

Both CABAC and CAVLC are lossless compression techniques. CABAC is only supported in the Main and higher profiles of the standard, as it requires a larger amount of processing to decode than CAVLC which does not compress the data quite as effectively. CABAC offers 10% better compression than CAVLC [6].

CABAC Entropy Encoding:

The design of CABAC involves the key elements of binarization, context modelling and binary arithmetic coding as shown in Fig. 2(a).

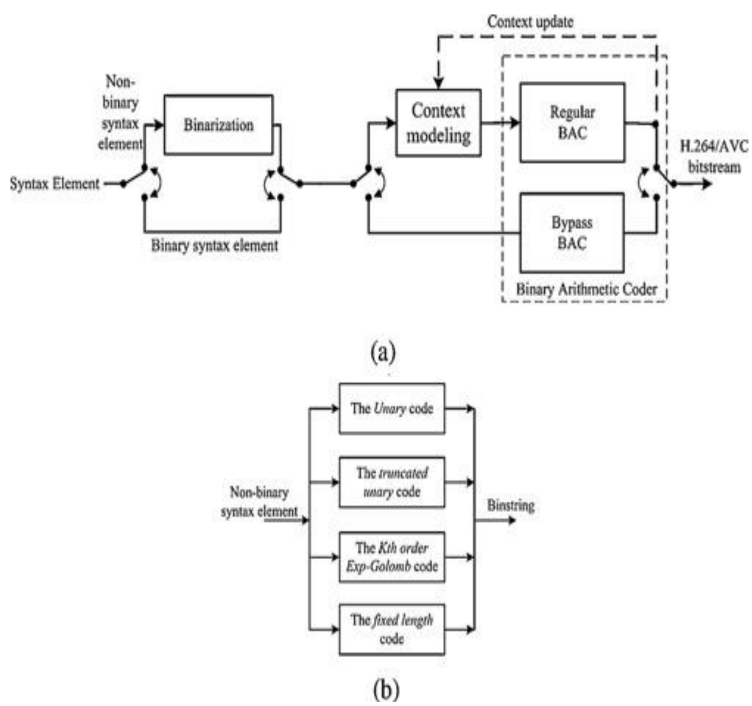

Fig. 2 (a) Block diagram of CABAC of H.264/AVC. (b) Binarization stage [6].

*1) Binarization***:**

A binarization scheme defines a unique mapping of syntax element values to sequences of binary decisions, so-called *bins*, which can also be interpreted in terms of a binary code tree. It is done on non-binary syntax elements which are converted to binary form called binstring. There are four basic code trees for binarization steps. as shown in Fig. 2(b).

2) Coding-Mode Decision and Context Modeling:

By decomposing each syntax element value into a sequence of bins, further processing of each bin value in CABAC depends on the associated coding-mode decision which can be either chosen as the *regular* or the *bypass* mode. In the regular coding mode, each bin value is encoded by using the regular binary arithmetic-coding engine. In context modeling, model is selected based on previous encoded binstring which is generated in binarization stage.

3) Adaptive Binary Coding Engine:

The Arithmetic coding engine used is based on the probability of symbol to be coded. Complexity reduced by allowing a simpler coding mode called "Bypass mode".

III. MAC LAYER CONSIDERATIONS

The IEEE 802.11 MAC layer aims to provide access control functions to the wireless channel such as access coordination, frame retransmission and check sequence generation. By adjusting the MAC parameters dynamically according to varying channel conditions and delay considerations one can achieve the improvements in the video transmission.

The objective of [7] is to investigate the effects of main parameters in a WLAN communication system, the effects of modulation modes at the physical layer, retry limits at the MAC layer and packet sizes at the application layer over the quality of media packet transmission. To maintain the delay as low as possible and high throughput, use lower retry limits in higher modulation modes, good channel condition with high SNR and in case of low SNR, lower modulation modes, higher retry limits, smaller packet size to achieve better performance.

IEEE 802.11 DCF makes use of CSMA/CA as access method [8]. Before initiating a transmission, each station senses a medium. If the medium is idle, the node waits for DCF interframe space DIFS before transmitting. If medium is busy, the station defers its transmission and initiates a backoff timer to avoid collisions, Backoff time is determined by CW (contention window). As a collision occurs, the station has to double the contention window. In DCF, once a station finishes a transmission, it waits a DIFS (Distributed Interframe Space) time. The IEEE 802.11e replaces DCF and PCF standard with HCF. In HCF, two channel access methods are used: HCCA and EDCA. EDCA was designed to enhance the DCF mechanism that can support service differentiation among different classes of traffic. EDCA supports QoS by introducing AC. EDCA has four AC acts as an independent backoff entity, that support priority based service. The service differentiation between these access categories is achieved by setting different contention window values (CWmin, CWmax), AIFS. AC is a queue and each queue has different AIFS time, CW time and retry limit. A higher priority queue will be assigned shorter AIFS time and CW time [9].

The IEEE 802.11 standard specifies four types of Interframe Spaces (IFS) utilized to define different priorities, namely Short Interframe Spaces (SIFS), Point Coordination IFS (PIFS), Distributed IFS (DIFS), and Arbitrary IFS (AIFS) as shown in Fig.3.

EDCA Collision:

Two types of collisions in the wireless channels are internal collision and external collision [10].

1) Internal collision: When more than one EDCF in the same station count their backoff timers to zero and try to transmit at the same time it leads to a station like internal collision OR
If two ACs finish their backoff at the same time in a station, then the station has an internal collision called virtual collision. To avoid such virtual collision a node selects one AC having the higher priority

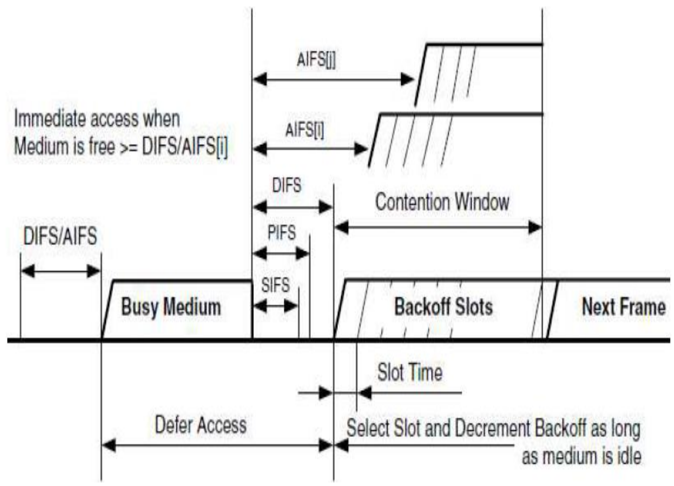

Fig. 3 Different IFS values in IEEE 802.11e EDCA

2) External collision: External collision occurs if backoff timers of the EDCFs at two or more stations reach zero at the same time and win access to the medium.

Each AC within a station behaves like an individual virtual station: it contends for access to the medium and independently starts its backoff procedure after detecting the channel being idle for at least an AIFS period. When a collision occurs among different ACs within the same station, the higher priority AC is granted the opportunity to transmit, while the lower priority AC suffers from a virtual collision, similar to a real collision outside the station.

Different MAC-Layer Adaption Techniques:

A. Adaptation of Retry limit

Retry limit parameter of IEEE 802.11 standard directly effects on the packet reliability whereas other parameters mostly effect on packet delay. According to the IEEE Standard 802.11 MAC when a transmitted packet is not acknowledged properly retries can be performed and repeated until a certain limit is reached. Packets are dropped when they reach their retry limits. Retry is an efficient parameter to improve the reliability of the link. By varying the Retry limit value of the ACs, the QoS optimization- throughput stability and minimum delay is achieved. Advantage of EDCA is that, it fully utilizes the channel bandwidth. By assigning a high value to the Retry limit, it gives the AC a high priority. There are different techniques to adapt the retry limit studied further.

1) Content-Aware Technique : Chih -Ming Chen [1] has proposed cross layer content aware retry limit adaptation (CA-RLA) scheme for wireless video transmission over IEEE 802.11 WLAN where transmitter retrieves the side information associated with the video bit stream as well as estimates the client channel conditions according to the estimated channel state information (CSI) and actual estimated back-off waiting statistics.

2) Priority queuing : The way a node manages delayed packets in its buffer, such as the order of receiving service or dropping, is called a queuing mechanism. PQ is referred to the type of service discipline in which multiple queues are maintained and associated with different priority levels. By combining the retry limit adaptation with priority queuing, performance of the transmitted video over WLANs is improved [11]. This technique uses the feedback from decoder side so it leads to delay which is not suitable for real time video transmission.

3) M/M/1 model : The effect of delay constraint on the quality of received packets is analyzed by "expired-time packet discard rate" (Pex). In the retry-limit adaptation the optimum retry-limit is obtained in order to minimize the "total packet loss rate" (PT) by virtue of the fact that increasing retry-limit will decrease "packet link loss rate" (PL) and increases both Packet overflow drop rate (POV) and expired-time packet drop rates. In this scenario each packet may be lost either due to drop from the queue at the wireless access point or due to channel errors at the wireless link. Packet dropping from the queue in turn can take place when the number of packets in the queue exceeds the buffer length or some packets become expired [12]. This technique is good which increases the throughput as it adapts the retry limit according to total packet loss rate and expired time packet discard rate. For real time video transmission the total packet loss rate can be calculated with the help of estimated CSI from the receiver.

4) Adaption of contention window, backoff timer/counter, AIFS in both DCF and EDCA: When the channel is sensed idle the transmission begins otherwise the station executes a backoff procedure after waiting a period of AIFS [AC]. The backoff mechanism of EDCA is different from the DCF. The EDCA is selected from[1,CW], instead of [0,CW −1] as the DCF. If two ACs finish their backoff at the same time in a station, then the station has an internal collision called virtual collision. To avoid such virtual collision a node selects one AC having the higher priority. In [13], CW is adjusted based on number of collisions. Both DCF and EDCA use random contention window to determine bakeoff intervals. Once a transmission is failed, it results in a larger contention window. This may cause two problems. First, video packets are still transmitting while deadlines were due. This will waste network bandwidth in transmitting invalid packets. Second, I-slice is the most critical slice for P/B-slice to refer to. As the number of stations increases, the number of collisions, average delay time and packet loss rate increase [2]

IV. PROPOSED CROSS LAYER DEIGN AND OPTIMIZATION

A layered architecture is the cross-layer optimization approach, which refers to protocol design by exploiting the dependence between protocol layers to obtain a better system performance. In cross layer technique, instead of considering a layer as a completely independent functional entity, information can be shared among layers in both senses: upper to lower layers and lower to upper layers. This information exchange can be used to optimize the overall performance of the system in a holistic way, by adapting the protocols functionalities in the presence of changing networking conditions. To support the varying Quality-of-Service (QoS) requirements of emerging applications, a new standard IEEE 802.11e has been specified. Consequently, several advanced mechanisms were proposed based on 802.11e to support multimedia transmissions and in particular video transmission quality. Most of the proposed mechanisms improved the performance by adjusting the operation of 802.11e MAC, such as Contention Window size, TXOP limit and data transmission rate.

The proposed Top-Down cross-layer design involves the mapping of H.264 video slices (packets) to appropriate access categories of IEEE 802.11e according to their information significance as shown in Fig. 4.

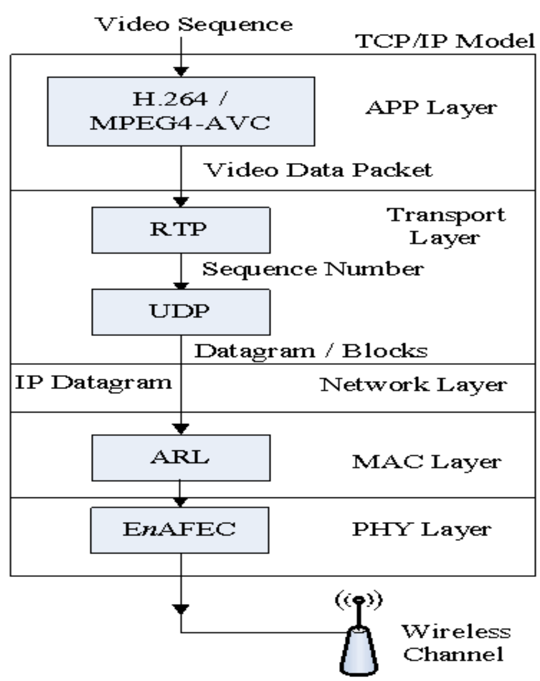

Fig. 4 Cross Layer Mechanism [14]

Various cross layer approaches for video transport over wireless network to achieve QoS are summarized as follows [2].

1. Top-down approach relies on the higher layer to optimize their parameters and the parameters of their next lower layer in top-down manner.

2. Bottom-up approach lets the lower layers insulate from the higher layers from losses and bandwidth variations.

3. Application-centric approach uses either top-down or bottom-up approach to allow the application layer optimizing the lower layer parameters on at a time. However, due to the slower timescales in application layer opration, this approach may not be optimal at all time.

4. MAC-centric approach, passing the traffic information and requirements from the application layer to the MAC layer to optimize the transmission.

5. Integrated approach mixes and matches the above approaches to provide the a combined strategy for cross-layer QoS design

Main parameters in a WLAN communication system with following attributes are:

• Network: A packet based ad-hoc network
• Channel: wireless LAN.
• Target layers: MAC and APP.
• Target parameters: retransmission limit and contention at MAC Layer and packet size at APP Layer.
• Assessment quantities: Delay and throughput.

QoS mapping algorithm for video over IEEE 802.11e EDCA Static Mapping:

Static mapping algorithm, based on the traffic specification of IEEE 802.11e EDCA, and encoded H.264 video data is allocated into different precedence AC queues according to the video coding significance. However, the mapping is static and not adaptive. When the network load is light, the video data which is mapped to lower priority AC will result in unnecessary transmission delays and packet losses [14].

Dynamic Mapping/802.11e:

In adaptive cross layer mapping algorithm, MPEG-4 video packets are dynamically mapped to the appropriate AC based on both the significance of the video data and the network traffic load. By exploiting the cross-layer mapping approach, we could prioritize the transmission of essential video data and improves the queue space utilization.

The proposed framework is based on three steps as: In the first step, the information of I/P/B slice type through cross layer is retrieved. This retrieved information is used for testing in IEEE 802.11e is a single-video multi-level queue methods in the second step. In the third step the mapping of H.264 video slices/packets to appropriate AC of IEEE 802.11e according to their information significance. Compared with IEEE 802.11 single queue, IEEE 802.11e priority multi-level queue is able to enhance bandwidth utilization as shown in Fig. 5. Each AC has its own buffered queue and behaves as an independent backoff entity. The priority among ACs is then determined by AC-specific parameters, called the EDCA parameter set. The EDCA parameter set includes minimum Contention Window size (CWmin), maximum Contention Window size (CWmax), Arbitration Inter Frame Space (AIFS), and Transmission Opportunity limit (TXOPlimit). The AC with the smallest AIFS has the highest priority, and a station needs to defer for its corresponding AIFS interval. The smaller the parameter values (such as AIFS, CWmin and CWmax) the greater the probability of gaining access to the medium.

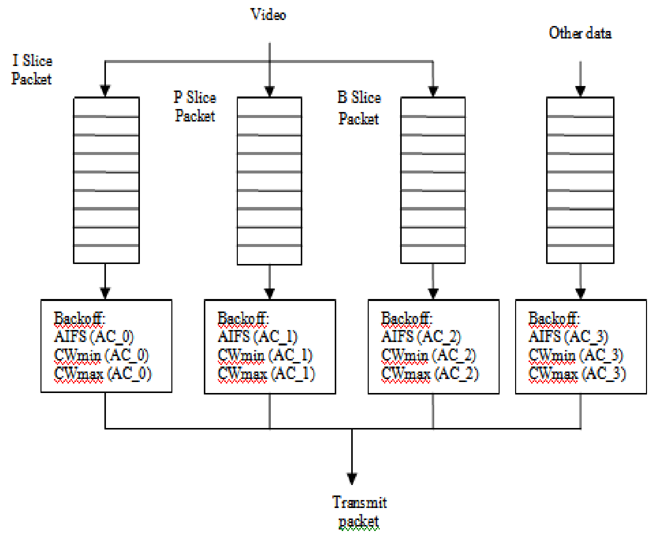

Fig. 5 Priority based AC's (i.e Single video multi-level queue)

Simulation topology

To evaluate the performance of proposed cross-layer mapping algorithm, simulation conducted using a widely adopted network simulator NS-2, and integrated with EvalVid as shown in Fig. 6.

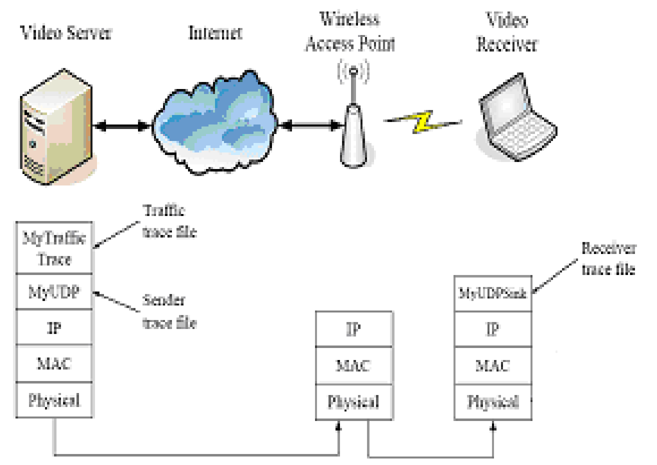

Fig. 6 operation flow of myEvalvid – NT for H.264/AVC.

Operation flow of myEvalvid – NT for H.264/AVC [9]:

1. Encode raw YUV video file into H.264/AVC format using JM.
2. Parse the H.264/AVC video file into traffic trace file which contains packet id, send time and packet size used for NS2.
3. After simulation, NS2 generates sender and receiver trace file.
4. Sender file contains packet id, order and send time. Receiver file contains packet id, order and receive time.
5. Calculate packet loss rate, delay time, jitter and throughput using trace file.
6. Reconstruct erroneous H.264 video file using trace file and Error Inserter.
7. Decode H.264/AVC video file into fixed YUV video using JM.

8. Compare video quality between raw and fixed YUV videos in terms of PSNR.

The video sources can be used in the simulation are YUV CIF (352 × 288) i.e Football and YUV QCIF (176 × 144) i.e Foreman. Foreman cantains 400 video frames fragmented into packets before transmission and maximum transmitted packet size over the simulated network is 1000 bytes. Table II and III shows the number of video frames and the packets of the video source Foreman.

TABLE II The amounts of video frames of the video source

Video	Format	Frame Number			Total
Foreman	QCIF	I	P	B	
		45	89	266	400

TABLE III The amounts of packets of the video sources

Video	Format	Packet Number			Total
Foreman	QCIF	I	P	B	
		237	149	273	659

There are two kinds of scenario in the simulations for evaluating the video transmission performance:

Scenario 1: in this case only video stream is transmitted from the video sender node to the video receiver node. In this scenario, the performance evaluation focused on the queue space utilization by witnessing the queue length variation of each AC.

Scenario 2: in this case we used light and heavy loading cases, including different loads of voice traffic (64k, in AC [3]), CBR (in AC [1]), and TCP (in AC [0]) and video in AC[2]. Traffic flows were randomly generated and transmitted over the entire simulation environment. In this scenario, analyzes the received video quality to evaluate the efficacy of proposed scheme under various network loading conditions.

The parameter settings of the proposed mapping algorithm are specified as follows: the threshold_low value of queue length is ten packets; the threshold_high value of queue length is forty packets; the downward mapping probability, prob_TYPE, for the 1 frame is 0, for P frame is 0.6, and for B frame is 0.9. The queue sizes of all ACs are limited to a maximum of fifty packets.

Queue space utilization of mapping algorithms

There are five parameters of the simulation. The first is the choice of mapping algorithm (0: IEEE 802.11e/dynamic mapping). The follow four mean the numbers of traffic flows of AC[3], AC[2], AC[1], and AC[0]. In the simulation, for light load, video flows to transmit in IEEE 802.11e network with other traffic. Then, a new file (queuelength_choice_0_voice_5_video_1_FTP_1_CBR_1.txt) is created. This file is the trace of the queue length. First field is the time stamp. The next four steps are the queue length of AC [3], AC[2], AC[1], and AC[0]. Fig. 9 shows the variation of queue length. Dynamic mapping algorithms use three queues (AC[2], AC[1], AC[0]) to transmit video packet, as showed in Fig. 9. The dynamic mapping provides better utilization of high priority queue than static mapping [14].

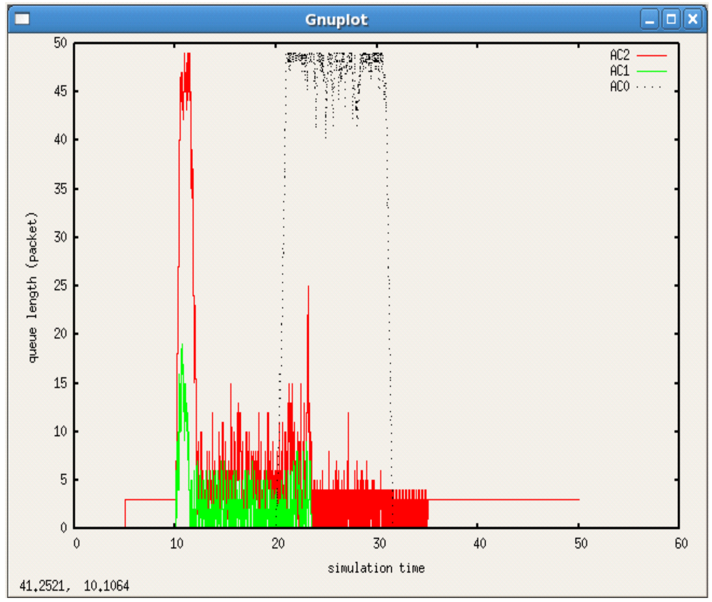

Fig. 9 Avg. Queuelength Vs Simulation time for Adaptive/Dynamic/802.11e EDCA Mapping

The fraction of decodable frame rate, in standard MPEG encoders generate three distinct types of frames, namely I, P, and B frames. Due to the hierarchical structure of MPEG, I frames are more important than P frames, and in turn P frames are more important than B frames. Therefore, a frame is considered decodable if, and only if, all the fragmented packets of this frame and the other packets that this frame depends on are completely received. Thus, the decodable frame rate (Q) is defined as the number of decodable frames over the total number of frames sent by a video source. The larger the Q value, the better the video quality perceived by the end user.

By comparing the traces of sending and receiving, we can find the loss of packet and video frame. Moreover, the video quality is also evaluated by the Decodable Frame Rate (Q). The result shown in Table V that the total number of loss video frame is 0 and the Decodable Frame Rate is 1.00 for dynamic mapping i.e 802.11e EDCA.

PSNR is one of the most widespread objective metrics to assess the application-level QoS of video transmissions. PSNR measures the error between a reconstructed image and the original one.

MOS is a subjective metric to measure digital video quality at the application level. This metric of the human quality impression is usually given on a scale that ranges from 1 (worst) to 5 (best). In this framework, the PSNR of every single frame can be approximated to the MOS scale using the mapping shown in Table IV

TABLE IV Possible PSNR to MOS conversion [3]

PSNR (dB)	MOS
>37	5 (Excellent)
31-37	4 (Good)
25-31	3 (Fair)
20-25	2 (Poor)
<20	1 (Bad)

The simulations results shown in Table V demonstrate that the proposed mapping algorithm achieves better QoS than the conventional methods such as the static mapping algorithm [14].

TABLE V The average PSNR and number of frames lost (light load)

Mapping Algorithm	Average PSNR (dB)	Q (Quality Factor)	Frame Loss Number			Total
Dynamic/802.11e EDCA Mapping	34.88	1	0	0	0	0

To solves the problem of transmission of real-time video over wireless using cross-layer is necessary. This technique may include APP layer with MAC layer with the objective of obtaining the successful transmission of video over the wireless LAN in order to minimize the total packet loss rate increasing the network throughput at MAC and H.264/AVC gives the better video quality and compression ratio at APP layer.

V. CONCLUSIONS

To support the varying Quality-of-Service (QoS) requirements of emerging applications, four access categories (ACs) have been defined in the IEEE 802.11e standard. Each AC has a different transmission priority, which implies the higher the transmission priority, the better the opportunity to transmit. In order to improve the transmission of video data over IP networks, theH.264/MPEG 4 AVC standard introduced. The proposed Adaptive Cross-layer Mapping algorithm for Video transmission over IEEE 802.11e Wireless Local Area Networks (WLANs). utilizes a cross-layer approach and dynamically assigns packets of different layers to one of the four ACs .The experiment results demonstrate that the proposed mapping algorithm achieves better QoS than the conventional methods such as the static mapping algorithm [14].

ACKNOWLEDGMENT

It is my pleasure to get this opportunity to thank my beloved and respected head of department of PG co- cordinator Dr. S. K. Shah and Prof. W. M. Mendre who imparted valuable basic knowledge of Electronics specifically related wireless communication. We are grateful to department of Electronics and Telecommunication, Smt. Kashibai Navale College of Engineering, Pune for providing us infrastructure facilities and moral support.

REFERENCES

[1] Chia-Wen Lin Chih-Ming Chen, "Cross-Layer Packet Retry Limit Adaptation for Video Transport over Wireless LANs," IEEE TRANSACTIONS, vol. 20, pp. 1148-1461, Nov 2010.

[2] Hung-Chin Jang,"Hybrid Design Framework for Video Streaming in IEEE 802.11e Wireless Network," 22nd International Conference on Advanced Information Networking And Application, 2008.

[3] Chang Wen CHEN, FENG Zhengyong," Video over IEEE802.11 Wireless LAN: A Brief Survey," May 2013.

[4] Atul Puri, Xuemin Chen,"Video coding using the H.264MPEG-4 AVC compression standard", ELSEVIER.

[5] Detlev Marpe,"CABAC in the H.264AVC Video Compression Standard", July 2003.

[6] Zafar Shahid, Marc Chaumont, William Puech," Fast Protection of H.264AVC by Selective Encryption of CAVLC and CABAC for I and P Frames" IEEE 2011.

[7] Mirghiasaldin Seyedebrahimi, Xiao-Hong Peng," Investigation of PHY, MAC and APP Layers for Adaptive and Cross-Layer Optimization in IEEE 802.11 WLAN," 2010 10th IEEE International Conference.

[8] www.google.com

[9] Hong Zhao, Nirwan Ansari, "Cross layer design for multimedia streaming over wireless 802.11e networks", 2011 IEEE.

[10] Member, Mihaela van der Schaar Qiong Li, "Providing Adaptive QoS to Layered Video Over Wireless Local Area Networks Through Real-Time Retry Limit Adaptation," IEEE TRANSACTIONS , VOL. 6, NO. 2, APRIL 2004.

[11] Mihaela van der Schaar, Hossein Bobarshad, "Analytical Modeling for Delay-Sensitive Video Over WLAN," IEEE TRANSACTIONS, vol. 14, pp. 401-414, april 2012.

[12] Ksentini, A., Naimi, M., and Gueroui, A.; "Toward an improvement of H.264 video transmission over IEEE 802.11e through a cross-layer architecture," IEEE Communications Magazine, Jan. 2006.

[13] Rathnakar Achary, V. Vaityanathan, Pethur Raj Chellaih, Nagarajan Srinivasan,"A New QoS Architecture for Performance Enhancement of IEEE 802.11e EDCA by Contention Window Adaption", 2012 IEEE.

[14] IEEE Std 802.11e-2005;"Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications Amendment 8: Medium Access Control (MAC) Quality of Service Enhancements", November 2005

[15] S. M. Koli ,R. G. Purandare, S. P. Kshirsagar, V. V. Gohokar, "End-to-End Performance Improvement of the Wireless Channel for Video Transmission", Springer Science+Business Media New York 2013.

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