Abstract - Today the great challenge proposed to the IEEE 802.11 [1] Wireless Lan is to support real time and multimedia applications. However, the characteristics of the wireless channel (low and fluctuating bandwidth link and the large error rate) post different problems in supporting the requirements on QoS (bandwidth, delays, jitters) of these sensitive applications. In this paper, we focus on the JVT H.26L video encoder, the Wireless lan (WLAN) network and theirs interaction in QoS. The interaction is made by the guarantee of a reliable H.26L video transport over the IEEE 802.11 Wireless Lan. In this context, we propose a novel cross layer architecture. This architecture is based on a marking scheme, which exploits the new propositions of the IEEE 802.11 E group for QoS support.

Keywords – QoS, H.26L, IEEE 802.11, WLAN

I. INTRODUCTION

Recently, the ITU-T and the ISO/IEC JTC [1] have decided to combine their efforts in the development of the emerging H.26L standard, which was initiated by the ITU-T committee. H.26L is being adopted by the two committees because it represents a departure in terms of performance from all existing video coding standards [2]. ISO/IEC MPEG joined by ITU-T VCEG to form a Joint Video Team (JVT) that took over the H.26L project of the ITU-T [3]. The JVT objective is to create a single video coding standard that would simultaneously result in a new part (likely Part-10) of the MPEG-4 family of standards and a new ITU-T (likely H.264) recommendation. The emerging H.26L standard has a number of features that distinguish it from existing standards [4], while at the same time, sharing common features with other existing standards. The following points are the key features of H.26L:

1. Up to 50% in bit rate savings: Compared to H.263v2 (H.263+) or MPEG-4 Simple Profile, H.26L permits an average reduction in bit rate by up to 50% for a similar degree of encoder optimization at most bit rates.
2. High quality video: H.26L offers consistently high video quality at all bit rates, including low bit rates.

Thereby, these features place the JVC coding as a serious alternative for an efficient video transmission over WLAN and third Generation networks.

Meanwhile, wireless communications are an emerging technology that became an essential feature of every day’s life. In this context the IEEE 802.11 WLAN standard is being accepted for many different environments. IEEE 802.11 is now considered as a wireless version of Ethernet. This is favoured by the development of: firstly The IEEE 802.11g [5], which has been touted as the next high speed standard for wireless lan communications. With data rates up to 54 Mbps and backwards compatibility with legacy 802.11b equipment, it sounds like the perfect marriage of next generation advanced technology with investment protection. Secondly, The IEEE 802.11e [6] developed to enhance the support of QoS sensitive applications, and provides a differentiation of service. Combined with H.26L, the enhanced IEEE 802.11 can support the more requiring applications (VOD, Visio conference and TV broadcasting), while being a serious alternative to wired networks. However, the use of the CSMA/CA algorithm posts different problem for the IEEE 802.11 to guarantee a QoS. This algorithm provides for all stations the same priority to transmit. Consequently, we can not distinct between a station with real time traffic and a station with best effort traffics.

Some previous work [7] [8], have study the behaviour of the video streaming over IEEE 802.11 and particularly the compression tool’s H.26L. All of them propose to solve the video streaming transport’s problem by using the robust error control. Error control is one of the most popular application-level approaches dealing with packet loss and delay in the multimedia communication over bandwidth limited fading wireless channels. It consists of Forward Error Correction (FEC). Motivated by the fact that, wireless link characteristics involve unpredictable burst errors, that is usually uncorrelated with instantaneous available bandwidth. The resulting packet losses and bit errors can have devastating effect on multimedia quality. To overcome residual BER (Bit Error Rate), loss recovery of video stream is usually required.

Even so, all these solutions address the QoS challenge of robust H.26L video streaming over IEEE 802.11 network only at application level QoS control. In this paper, we investigate interaction’s QoS between H.26L video application and IEEE 802.11e at the MAC layer, through the mapping of the H.26L elementary stream. In other words, our contribution consists in a marking
algorithm for the TC (Traffic Category) of IEEE 802.11e, this component is essential to provide end to end QoS.

This paper is organized as follows: section II, provides an overview of H.26L system architecture. In section III, we present the IEEE 802.11 wireless LAN and the enhancement proposed by the e group. We describe our architecture and the marking algorithm in section IV. Simulation and performance is carried through the NS-2 Network Simulator [9], and presented in last section.

II. H.26L/JVT STANDARD OVERVIEW

H.26L consists of two conceptually different layers: (1) The Video Coding Layer (VCL) contains the specification of the compression engine-mechanism such as motion compensation, transform coding of coefficients, and entropy coding. The VCL is in so far transport unaware. The highest data structure the VCL is concerned with is traditionally known as a Slice – a collection of coded macro blocks in scan order. (2) The Network Adaptation Layer (NAL) is responsible for the encapsulation of the coded slices into transport entities of the network. The VCL layer is not in the scope of this paper, but we will interest particularly to the NAL layer.

A. Network Abstraction Layer

The Network Abstraction Layer of JVT video, defines the interface between the video codec itself and the outside world. It operates on Network Abstraction Layer Units (NALUs) which gives support for the packet-based approach of most existing networks. A NALU consists of a one-byte header and a bit string that is, in most cases, the bits representing the macroblocks of a slice. The header byte itself consists of: the aforementioned error flag, a disposable NALU flag, and the NALU type. Finally, the NAL provides means to transport high-level syntax, i.e., syntax which is assigned to more than one slice, e.g. to a picture, a group of pictures to an entire sequence. As the applied parameter concept used in JVT is significantly different to previous video coding.

B. Parameter Set Concept

One of the key problems of robust video transmission in packet-lossy environments results from the layered nature of all current video coding standards. Information in the slice/picture/GOP (Group of pictures)/sequence headers is necessary for the reconstruction of the whole slice/picture/GOP/sequence, but traditionally coded only once at the start of each Slice/picture/GOP/sequence in order to save bits. A loss of a packet containing a header renders all following packets containing data that rely on the lost header useless. Therefore, a fundamentally new approach was taken in H.26L/JVT video. The synchronous, real-time media transmission consists entirely of packets that are completely self-contained. That is, each packet can be reconstructed without relying on information of other packets. The slice layer was identified as the appropriate smallest self-contained unit, because the size of slices can be adjusted to be small enough to fit into the MTU (Maximum Transport Unit) size of the most demanding system in this regard. All information at the higher layers is conveyed asynchronously. Of course, there are a few picture and GOP parameters that may change during the existence of a session. Parameters that change very frequently are added to the slice layer – this is in particularly true for the Frame Number (that signals the decoding order of pictures). All other parameters are collected in a so-called Parameter Set. Encoder and Decoder(s) maintain a synchronized set of such Parameter Sets. Which of the (potentially many) Parameter Sets the decoder should use to reconstructed on coded slice is defined by a codeword in the slice header of the VCL data. Fig. 1 presents this concept. The JVT standard specifies a method to convey Parameter Sets in a special NAL unit type, the Parameter Set information packet.

III. IEEE 802.11 WIRELESS LAN

The IEEE 802.11 MAC layer defines two relative medium access coordination mechanisms: Distributed Coordination Function (DCF), and Point Coordination Function (PCF). The transmission medium can operate both in contention mode (DCF) and contention-free mode (PCF). The DCF is basically an asynchronous mode of operation supporting delay insensitive data transmission. PCF on the other hand is synchronous and meant for delay sensitive data transmission and used in conjunction with DCF.

A. DCF: Distributed Coordination Function

The DCF is the basic mechanism for IEEE 802.11 employing Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) as the access method. Before a node can access the channel, it senses the medium. Several cases are possible: (1) It is idle; the node waits for DCF inter frame space (DIFS) before transmitting. (2) It is busy; the node it randomly chooses a back off time, measured in time slots, from the interval \([0, CW]\) where \(CW\) is called the contention window. Whenever the medium is idle the back off timer is decremented for each time slot the medium remains idle however if the medium is sensed busy the back off timer is frozen. When the back off timer is null and the medium is idle, the node waits DIFS amount of time before getting access to the channel. In case of a collision,
communicated through lack of an acknowledgement e, the size of the contention window is doubled according to the relation:

\[ CW = (CW_{\text{init}} \times 2^i) - 1 \]

(1)

Where \( i \) is the number of transmission attempts.

After each successful transmission the node again performs a random back off even if the medium is sensed idle (Fig. 2 shows the DCF mechanism).

![DCF mechanism](image)

**Fig. 2.** The DCF mechanism

### B. PCF: Point Coordination Function

PCF on the other hand is the optional polling mechanism. It requires presence of a Point Coordinator (PC) usually the Access Point (AP). As with PCF support DCF must coexist and the time are divided into super frames. Each super frame has a contention free period (CFP), where PCF is employed and contention period (CP) where DCF is used. The PC maintains a list of nodes that have requested to be polled to send data. The nodes are polled under some priority or round robin mechanism. Whenever a node is polled it has a right to send data on the channel. Basically, PCF was designed to support real-time traffic. However, PCF involves several draw back, among which excessive data control overhead and scalability lack.

### C. IEEE 802.11e and its enhancements

The need for a better access mechanism with an aim of providing service differentiation has led task group E of the IEEE 802.11, working group come up an extension to the IEEE 802.11 standard called 802.11e. The QoS support is realized with the introduction of Traffic Categories (TCs). Each TC maintains TC specific parameters: Arbitration Inter-frame Space AIFS[TC], CWmin[TC], Persistence Factor[TC]. Each station maintains multiple backoff instances parameterized with TC specific parameters. MSDUs are now delivered through these multiple backoff instances instead of a single instance. The new parameters that have been proposed are: (i) AIFS: At least DIFS and can be enlarged individually for each TC. (ii) Persistent Factor (PF): It determines the degree of increase of the contention window when collision occurs. Higher priority traffic will have lesser PF, than lower priority traffic’s PF value. This implies when collisions occur, CW for higher priority traffic will increase lesser value than lower priority traffic’s CW value. Service differentiation under EDCF is achieved by providing different CWmin for each backoff instance corresponding to priority classes. Further, different inter-frame space can be used for different priority classes.

**IV. PROPOSAL OF A RELIABLE TRANSPORT OF H.26L VIDEO STREAM OVER IEEE 802.11**

Commonly, H.26L uses hierarchical coding for resolving scalability and heterogeneity issues. Based on the idea that coding will be in quality hierarchy form, where the lowest layer of hierarchy contains the minimum information for intelligibility. Succeeding layers of the hierarchy adds increasing quality to the scheme. Different coding modes exist: Space scalability allows the decoder to treat a subset of streams produced by the coder to rebuild and display textures, images with a reduced resolution. Temporal scalability allows the coder to treat a subset of streams produced by the coder to rebuild and display a video with reduced temporal resolution. With SNR (signal to Noise ratio), the coder transmits the difference between the original image and proceeding. This allows improving subjective quality of the final image. Moreover, in H.26L, there is a signalling stream “Parameter set Information”, which is sensitive and need to be preserved from errors and loss during transmission. Hence, the key solution of a reliable transport of H.26L streams is to privilege some critical H.26L’s streams among others. These critical layers are considered as essential for an acceptable rending of the global video stream (e.g. corresponding to a minimum QoS).

To implement this solution in the IEEE 802.11 network, we use the suggestion of the group E, which guarantee QoS in IEEE 802.11. In fact, the definition of several traffic categories allows us to make a differentiation between H.26L’s streams. In this context, we propose a novel marking algorithm. This algorithm permits to link the different H.26L streams with the traffic categories, while respecting the stream priority.

An other open issues regarding the design of an efficient transport of the H.26L video applications are summarized in the following: (1) What is the appropriate Traffic category that guarantees better QoS, (2) What are the values of the CW and AIFS, which guarantee a reliable transport of H.26L’s most important packets (Parameter set information). If we see on the traffic categories choice, it is clear that in case of the Parameter set information packets which are sensitive to packets loss, they will be transmitted with high priority. Hence, they correspond to the Traffic category 0. Further, the base and enhanced layer which accept loss, they will be transmitted in less priority traffic category. However, it is obvious that base layer stream have more priority then the enhanced layer stream, therefore the traffic stream category 1 corresponds to the base layer stream and finally the traffic category 3 and 4, corresponds to the enhanced layer 1 and enhanced layer stream2. We recall that the IEEE 802.11e group defines currently eight Traffic categories.

To distinguish between the traffic categories, we will use different CW and AIFS. These values are chosen according to traffic category’s priority. In fact, lower the CW and AIFS, higher is the priority of the Traffic Category (TC). In
our proposal, the association between the TC and the H.26L stream is based on the NALU’s NRI field. Note that NRI field is on 2 bits, it indicates the priority of the current NALU packet. Thereby, the NAL layer associates each H.26L stream with a NRI value. Then according to this NRI fields the NALU packet is placed in his corresponding TC queue at the MAC layer (see Fig. 3).

![Fig. 3. Architecture concepts](image)

**V. SIMULATIONS AND RESULTS:**

![Fig. 4. The H.26L Elementary stream bit-rate](image)

The traffic is a simulated multimedia H.26L traffic. In our simulation, the H.26L video stream was obtained by using three elementary streams, plus a stream which represents the Parameter set information. In this context, we have used a video component of the H.26L foreman sequence. Parameter set information was generated according to CBR (Constant Bit rate) traffic. In addition, three video stream were generated which corresponds to: (i) The first stream is the H.26L base layer video stream, it offers minimum QoS, (ii) The second stream is the H.26L enhanced layer 1 stream, it improve minimum QoS to offer medium QoS, (iii) The last stream is the H.26L enhanced layer 2 stream, it improve the two precedent streams to propose maximum QoS. The Fig. 4 shows the H.26L video bit rate sent from the H.26L server to the client. We compare H.26L’s performances under EDCF (differentiation between the layers) and under DCF (No differentiation between the layers).

### A. Network architecture

We used the network architecture shown in Fig. 5, to simulate unicast service provided by the server attached to the node server. The server sends H.26L stream to the client attached to node Client. We include three ftp data traffics over TCP (with no Ack) to overload the wireless network.

![Fig. 5: The network architecture](image)

### B. The Wireless Parameters:

In order to differentiate the streams under EDCF, we use different CW and AIFS. Under DCF we use one value for the two parameters CW and DIFS. Concerning the physical parameters; we use the same for each DCF and EDCF. We summarize the parameters used in the table 1 and 2.

<table>
<thead>
<tr>
<th>Parameter Set Information (TC 0)</th>
<th>CW</th>
<th>AIFS (µs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Layer stream (TC1)</td>
<td>50</td>
<td>31</td>
</tr>
<tr>
<td>Enhanced 1 Layer stream (TC2)</td>
<td>70</td>
<td>63</td>
</tr>
<tr>
<td>Enhanced 2 Layer stream (TC3)</td>
<td>90</td>
<td>63</td>
</tr>
</tbody>
</table>

**Table 1 EDCF MAC parameters**

<table>
<thead>
<tr>
<th>Parameter Set Information (TC 0)</th>
<th>CW</th>
<th>DIFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Layer stream (TC1)</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>Enhanced 1 Layer stream (TC2)</td>
<td>70</td>
<td>63</td>
</tr>
<tr>
<td>Enhanced 2 Layer stream (TC3)</td>
<td>90</td>
<td>63</td>
</tr>
</tbody>
</table>

**Table 2 DCF parameters**

### C. Results

![Fig. 6. Parameter set information packets loss](image)

Fig. 6 represents the packet loss rate measured for the most important packets of the H.26L video stream as to know Parameters set information. The packets transmitted over EDCF scheme, did not undergo a loss, compared to DCF. In addition, the packet loss exceeds in some case the 50% of the stream. The packet loss saving in EDCF is principally due to the priority assigned to the parameter set information in EDCF. Indeed, the CW and AIFS used by the TC0 (Parameter set information packets) are the smallest, therefore this TC have always a priority over the others TCs.
The Fig. 7 illustrates the packets loss percentage of the base layer stream (minimum QoS), we notice that the two mechanisms (EDCF and DCF) give practically the same packet loss percentage. In fact, the mean packets loss is about 8% for the two mechanisms. The Fig. 8 shows the packets loss percentage of the two enhanced layer stream. We can see that DCF gives a better performance then EDCF, this is due to the fact that DCF makes no difference between the different stream.

Contrariwise, in EDCF this stream have less priority then the base layer stream, and Parameter set information.

The Fig. 9 presents the end-to-end delays of the base layer stream, it is clearly seen that EDCF outperforms DCF, where the mean packets delay is roughly 0.35 s with DCF, and only about 0.25 s when using EDCF marking algorithm. The Fig. 10, illustrates the end-to-end delay of the two enhanced layer stream, we also notice that EDCF have harmful performance then DCF, this is due to the same reasons cited for the packets loss.

VI. CONCLUSION

In this paper, we presented a novel approach for a reliable transport of the H.26L video over wireless channels, by combining the H.26L’s hierarchy encoded stream and the new proposition of the IEEE 802.11e group. The simulations have shown that the proposed scheme achieves considerable improvement than DCF, particularly on minimizing packet loss of sensitive video data (as to know Parameter set information). Further, a significant reduction of the end-to-end packet transfer delay is obtained. The proposed marking scheme better takes into account the characteristics of the hierarchic encoding of the H.26L and, the differentiation mechanism given by the IEEE 802.11e network. In fact, we can associate the different streams with the traffic categories, and give the higher priority to the sensitive stream.

Our future works will focus on the extension of our marking scheme to the internet, and associate the Traffic Category of the IEEE 802.11e with the different class proposed by the DiffServ scheme.

REFERENCES
