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# Packet-based polling scheme for video transmission in IEEE 802.11e WLANs

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**Abstract**

IEEE 802.11e standard introduces HCF Controlled Channel Access (HCCA) to support quality of service (QoS) for multimedia traffics. In HCCA, the traffics scheduled according to their mean characteristics which favors the Constant Bit Rate (CBR) transmission approach. However, it does not efficiently cope with the fluctuation of the Variable Bit Rate (VBR) video streams where the traffic shows deviation from its mean during the traffic lifetime. In this paper, we propose a packet based polling mechanism to enhance the scheduling of pre-recorded VBR video streams in HCCA function. Our approach exploits feedback information about the arrival time of the subsequent video frame obtained through cross-layering approach to accurately schedule the uplink traffics. Simulation experiments reveal the efficiency of the proposed mechanism in providing less delay and high throughput while maintaining medium channel.



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*Keywords:* Quality of Service (QoS); 802.11e; Medium Access Control (MAC); HCCA; Polling; H.263

## 1. Introduction

Recently IEEE 802.11 has become one of the massively deployed technology in the residential and public places such as apartments, stock markets, campuses, airports, etc. Due to some of its key features like deployment flexibility, infrastructure simplicity and cost effectiveness, there has been a recent trend toward providing an ubiquitous wireless access environment. This tendency leads to the presence of many multimedia applications with various traffic characteristics. In the future, it is widely expected that next generation wireless networks will be carrying a large portion of encoded video streams, two-third of all traffics in the networks will be video by 2017 according to Cisco Visual Networking Index[1]. IEEE 802.11 WLANs[2] were designed for the transmission of the best effort services which are no longer sufficient to meet the vast growth of time-bounded services that require rigorous Quality of Service (QoS) requirements such as channel bandwidth, delay and jitter[3,4]. Since Medium Access Control (MAC) layer functions

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are not QoS-oriented, guaranteeing QoS in a such layer has become a challenging task. IEEE 802.11 Task Group E (TGe) has presented IEEE 802.11e standard to improve the QoS support of multimedia streaming over WLANs.

The IEEE 802.11e introduced differentiated QoS services through a novel Hybrid Coordination Function (HCF) which is included in the recent standard, released on 2007[5]. A new revised version with technical enhancements on MAC and Physical layer has been launched on 2012[6]. The HCF introduces a new controlled access mode for MAC called HCCA. In HCCA, parameterized QoS support is achieved through scheduling QoS-enabled Stations (QSTAs) traffics in a The Basic Service Set (BSS) based on their negotiated QoS with the Hybrid Coordinator (HC) which is usually collocated with the Access Point (AP). Newly joined QSTAs are admitted to the system, asserting that previously admitted services are not jeopardized. HCCA is promising scheme for supporting QoS for delay-constrained applications such as VoIP and video streams compared to its counterpart (Enhanced Distributed Channel Access (EDCA)). This is due to the fact of eliminating the backoff counter overhead and the collision caused by the hidden node which is inherent in distributed access mode.

Although, the reference HCCA schedules traffics upon their negotiated QoS requirements in the first place, it is only efficient for CBR applications such as CBR G.711[7] audio streams and H.261[8] video (MPEG-1). However, it is not convenient to deal with the fluctuation of the VBR traffic such as H.263[9] video streams and G.718[10] audio traffic, where neither the packet size nor the packet generation time is constant. This consequently leads to a remarkable increase in the end to end delay of the delivered traffics and degradation in the channel bandwidth utilization as well.

The HC which resides in QoS-enabled Acces Point (QAP) maintains separate queues for the downlink traffic streams while the uplink streams are maintained in QSTAs' queues. For this reason, the HC can allocate time resources for its queues easily, yet it is unable to predict the amount of the VBR uplink traffics due to the fact that it is physically separated from the QSTAs. Several mechanisms such as[11,12,13] have been recently proposed to remedy the deficiency of the HCCA reference scheduler in supporting QoS for VBR video traffics. However, these enhancements still not sufficient to cope with the fast fluctuating nature of high compressed video applications due to the difficulty of accurately predict the VBR traffic profile. Recently,[14,15] present Adaptive TXOP assignment and its multi-polling enhancement for QoS provision of the VBR videos which show variability in packet size with fixed packet inter-arrival time such as MPEG-4.

With the increase of Internet web applications in the wireless mobile devices, the User-Generated Content (UGC) such as pre-recorded video streams have become more prominent nowadays. To the best of our knowledge, the scheduling of uplink pre-recorded continuous media in HCCA has not been addressed efficiently despite the fast growth of uplink streams of the UGC on the Internet such as pre-recorded video streams. In this paper, we present an enhancement on the HCCA polling scheme. The proposed scheme adjusts the legacy polling based on the feedback information sent to the HC in order to accommodate to the fast changing of the VBR traffics which show variability in the packet generation interval such as H.263 streams. This scheme makes use of the queue size field of QoS data frame in the MAC header of the IEEE 802.11e to carry this information to the HC, this is discussed in details in Section 2.

The rest of this paper is organized as follows: Section 2 explains the proposed algorithm. The performance evaluation and discussion is presented in Section 3. Section 4 concludes the study presented in this paper.

## 2. Proposed scheme

Since HCCA schedules QSTA based on negotiated TS Specifications (TSPECs) which represent their mean traffic characteristics, it is not efficient to cope with the variable profile of VBR traffic streams. Polling all QSTAs at the same Service Interval (SI) period may cause degradation in the channel utilization since some QSTAs are not ready to send data and thus reply to poll by a Null-Frames. The following section discusses the over-polling problem in HCCA and its impact on the delay and bandwidth utilization.

### *2.1. Preliminary study of HCCA polling scheme*

Consider Fig. 1 where number of VBR traffics are scheduled in one SI. The beacon interval is 200 ms and three QSTAs are scheduled every 40 ms. Assume that the first SI begins at time 0 and all QSTAs commence their traffics at that time. In this example, all QSTAs will use their Transmission Opportunity (TXOP) duration at the first SI since