2006년도 대한전자공학회 하계종합학술대회 제29권 제1호

IEEE 802.11e WLAN을 위한 효율적인 퍼지 예측 기반 스케줄링 방법

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An Efficient Scheduling Scheme based on Fuzzy Prediction for IEEE 802.11e WLAN

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Abstract

The IEEE 802.11e medium access control (MAC) is an emerging standard to support Quality of Service (QoS). A HCCA (HCF controlled channel access) scheduler of the standard IEEE 802.11e is only efficient for flows with strict constant bit rate (CBR) characteristics. In this paper, we propose a new HCCA scheduling scheme that aims to be efficient for both CBR and VBR flows. The proposed scheme uses fuzzy queue length predictions to tune its time allocation to stations. We present a set of simulations and provide performance comparisons with the reference HCCA scheduler.

I. Introduction

IEEE 802.11 wireless local area network (WLAN) is one of the most deployed wireless technologies all over the world. However, the 802.11 medium access control (MAC) has not considered quality of service (QoS) requirements and does not support a service differentiation. A new hybrid coordination function (HCF) has been proposed in the 802.11e standard to enhance the QoS support [1]. In order to guarantee the strict QoS requirements, a hybrid coordinator (HC) needs to schedule the various kinds of traffic efficiently. The 802.11e standard proposes a reference HCF controlled channel access (HCCA) scheduler that is efficient for flows with strict constant bit rate (CBR) characteristics. The reference HCCA scheduler allocates a transmission time based on the averaged values of the traffic characteristics of the flows, such as mean packet size and mean data rate. As described in [3], with variable bit rate (VBR) traffic the reference HCCA scheduler can be inefficient and unsuitable during the polling-based medium access.

To address the traffic variability, we propose a new scheduling algorithm which is efficient for both CBR and VBR flows. The proposed scheme is designed to guarantee the minimum of all the service interval requirements. To allocate the transmission time to the QoS stations (QSTAs), the proposed scheme uses the average transmission opportunity (TXOP) and allows nodes to adapt their real queue lengths using the estimated queue length value obtained by fuzzy predictor.

II. Proposed Scheme

It is needed to predict a queue length of each traffic stream (TS) in the next service interval so that HC can adjust the TXOP efficiently for VBR flows. To predict the queue length, we adopt Khedkar and Keshav's exponential average predictor which is based on the fuzzy logic control [2]. The general form

of exponential average predictor is following:

$$\hat{X}_{t,1} = \alpha \times \hat{X}_{t-1,1} + (1-\alpha) \times X_t \qquad (1)$$

where $\hat{X}_{t,1}$ means one-step predicted value of $X_{t,1}$ generated at the moment *t-1*, X_t is real value at *t* and α is the weighted value to past history. A prediction error is input of fuzzy logic and α is output value of fuzzy logic which in result is adjusted according to the proportional prediction error.

The proposed scheduling scheme takes the predicted queue length into account to support both CBR and VBR traffic. Our scheme consists of redistributing a part of the remaining controlled access phase (CAP) time to each QSTA in order to absorb some possible peak sending rates of VBR flows.

The scheduler calculates the additional required TXOP time for each TS of each QSTA according to the predicted queue length. All additional required TXOPs can be allocated if the remaining CAP time is large enough. If not, the additional required TXOPs are scheduled based on the weighted fair queueing (WFQ) discipline.

Ⅲ. Simulation Results

We performed a detailed study of the proposed scheme using ns2 network simulator with our extension codes based on the wireless modules. 6 QSTAs send a high priority CBR on-off audio trafffic (64kbps), a VBR video traffic (200kbps of average sending rate) with medium priority and a CBR MPEG4 video traffic with low priority to the QAP each.

Figure 1, 2 show the mean latency of each scheme, respectively. For the proposed scheme, the graph shows that all the flows have a maximum latency which corresponds to the service interval requirements of the different flows whereas for standard 802.11e, some flows may not have their QoS requirements met. The simulation results show that the proposed scheme can meet the service requirements in terms of the latency while providing the required bandwidth of each flow.

IV. Conclusion

We have designed and evaluated a new scheduling scheme for 802.11e HCCA with the aim of supporting fluctuating rates and packet sizes while remaining fair for the different types of flows with QoS requirements. To allocate TXOPs, the proposed scheduling scheme uses the mean sending rate of flows and the estimated queue length information obtained by fuzzy predictor.

The proposed scheme is shown to be more efficient than the reference 802.11e HCCA scheduler with our simulations. By this way, the proposed scheme allows to save much of the time allocated to the VBR flows.

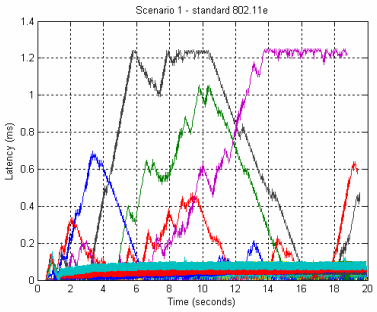

Figure 1 Mean Latency for the Standard 802.11e

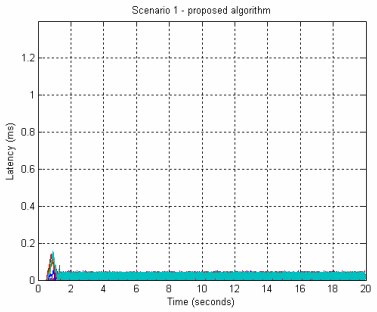

Figure 2 Mean Latency for the proposed scheme

References

[1] IEEE Std. 802.11e, "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Medium Access Control (MAC) Quality of Service (QoS) Enhancements," Nov. 2005.

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[3] N. Ramos, D. Panigrahi, , and S. Dey, "Dynamic Adaptation Policies to Improve Quality of Service of Multimedia Applications in WLAN Networks," Proc. Intl. Wksp. Broadband Wireless Multimedia, Oct. 2004.