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Delay Awareness Algorithm for Dynamic Adaptation in Wireless Networks

Kalaiyarasi.R[1], Deepa.S[2]

B.Tech., Department of ECE, Periyar Maniammai Institute of Science & Technology, Vallam, Thanjavur, TamilNadu, India.

B.Tech., Department of ECE, Periyar Maniammai Institute of Science & Technology, Vallam, Thanjavur, TamilNadu, India.

ABSTRACT: The term Quality of service [QOS] refers to prioritization and resourse reservation for users. Presently, Enhanced Distributed Channel Access (EDCA) protocol is used for providing differentiated quality-of-service. EDCA is a QoS for channel acess. With EDCA, high-priority traffic has a higher chance of being sent than low-priority traffic: a station with high priority traffic waits a little less before it sends its packet, on average, than a station with low priority traffic. Considering the channel access delay and throughput for performance improvement a different protocol is needed. The main problem usually faced is as follows: the past system collision avoidance mechanism using backoff algorithm can be inefficient for providing improved performance with respect to throughput and channel access delay, especially in a high network configuration (i.e. number of stations) with imperfect wireless channel. So the alternate solutions is identified to overcome the issue. The cumulative improvement of both the throughput and the channel access delay at runtime is to be considered. Using the delay deviation ratio and channel busyness ratio—of the present delay level and channel congestion status of the network, respectively a new algorithm is proposed.

KEYWORDS: Dynamic Adaptation, CW Tuning, Improvement of Performance, IEEE Consortium with 802.11 Standard.

I. INTRODUCTION

In distributed contention-based channel access schemes, collision is almost an unavoidable event. Both the IEEE 802.11 and 802.11e protocols adopt carrier sense multiple access (CSMA) and binary exponential backoff (BEB) for collision management. The BEB algorithm actually avoids collision by time-spreading of the users' accesses, and, thus, increases the throughput. However, time-spreading channel access results in increased channel access delay due to the increased contention window (CW). On the other hand, the reduction of channel access delay generally increases the collision probability, which, in turn, increases the risk of reduced network performance in terms of throughput. Therefore, it is accepted in the research community that the backoff algorithm plays a significant role in achieving a high aggregated throughput and less medium access delay. In brief, a backoff algorithm should be adaptive with both the collision rate and experienced delay for achieving reasonably high throughput and less delay.

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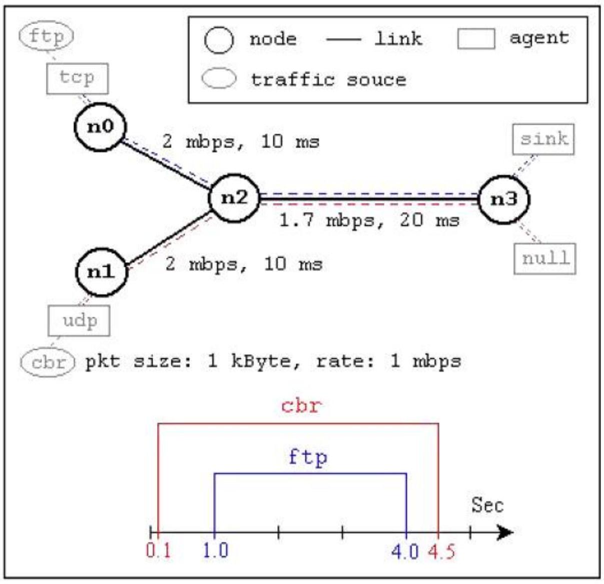

Fig.1 A Simple Network Topology and Simulation Scenario

Several authors have proposed different methods on backoff parameter tuning for increasing the performance of medium access protocols in the IEEE 802.11 networks. However, their tuning mechanisms perform one-sided tuning as they improve the network performance with respect to throughput, but not the channel access delay. Except the works in all the other works did not consider the variation of frame drop probability depending on the wireless channel status, i.e., bit error rate (BER). Furthermore, a station, in the prior schemes, does not explicitly concern the performance degradation of other stations with respect to the average channel access delay, which is another important consideration of this work. In this project, we propose delay-aware distributed dynamic adaptation of contention window (D2D) scheme for optimizing both the throughput and the channel access delay in a saturated network.

The D2D mechanism requires two estimates-delay deviation ratio (u) and channel busyness ratio (v) on present delay level and congestion status, respectively. The delay deviation ratio indicates the rate of increment of channel access delay of a station with respect to the average access delay of the network, and the channel busyness ratio indicates the rate of channel activity due to successful and failed transmissions.

The legacy backoff mechanism BEB performs blind resetting of CW to its minimum value after a successful transmission, which allows the station to get the channel access with higher priority in the next attempt. In such settings, a station does not take care of other stations for minimizing their respective channel access delays. It also does not consider the present channel congestion status, which might not be equivalent to the minimum CW size.

Unlike BEB, the proposed scheme D2D performs a probabilistic resetting of CW to its minimum value after a successful frame transmission. This probability, named as increment-decrement probability (q), is determined by the estimates of u and v. The basic idea is that, if a station experiences adequate channel access delay, the station should not increase the channel access delay of other stations by blind resetting of CW to its minimum value. Similarly, the D2D scheme prevents a station from blind increment of CW proceeding by a failed transmission. Each station probabilistically maintains the same CW, if the experienced delay is significantly high during a frame transmission process. In this case, the basic motivation is that, for a particular frame transmission, a station should not contribute high delay which can cumulatively affect the average medium access delay in long run.

The D2D scheme is adaptive in nature with the change of congestion level. It probabilistically adjusts the value of CW after both the failed and successful transmissions. In a highly congested channel, the D2D estimates lower value of q for maintaining the same CW preceded by a successful transmission, whereas the estimated probability for maintaining the same CW reduces after a colliding transmission.

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Therefore, the D2D ensures a proper timely reaction to the fast reduction of channel contention. We seamlessly integrate the proposed D2D scheme with the QoS version of the IEEE 802.11 medium access control (MAC) protocol. For the integration with the enhanced distributed channel access (EDCA) protocol, we need to modify only the backoff algorithm used for collision avoidance.

II. EXISTING APPROACHES – A SUMMARY

The existing and emerging works have devoted considerable attention on tuning the back off parameters for achieving optimal throughput only. The prior works do not consider the channel access delay and throughput metrics altogether for performance improvement. Additionally, in most of the cases, the optimal configuration of backoff parameters is performed by a centralized controller. The existing work contains several disadvantages, some of them are listed below: (a) Increases the risk of reduced network performance in terms of throughput. Therefore, it is accepted in the research community that the back off algorithm plays a significant role in achieving a high aggregated throughput and less medium access delay. (b) Their tuning mechanisms perform one-sided tuning as they improve the network performance with respect to throughput, but not the channel access delay.

III. PROPOSED SYSTEM SUMMARY

We propose a delay-aware distributed dynamic adaptation of contention window scheme, namely D2D, for the cumulative improvement of both the throughput and the channel access delay at runtime. The D2D scheme requires two ad-hoc, distributed, and easy-to-obtain estimates – delay deviation ratio and channel busyness ratio – of the present delay level and channel congestion status of the network, respectively. A key advantage of the D2D scheme is that it is compliant with the IEEE 802.11 standard, and, thus, can be seamlessly integrals with the existing wireless card. We show the integrated model of the medium access control protocol, namely D2D Channel Access (D2DCA), for the IEEE 802.11e networks. We further propose a two dimensional Markov chain model of the D2DCA protocol for analyzing its theoretical performance in saturated networks with imperfect wireless channel. Theoretical comparison with the benchmark protocols establishes the effectiveness of the D2DCA protocol. The proposed system contains several advantages, some of them are listed below: Delay-aware distributed dynamic adaptation of contention window (D2D) scheme for optimizing both the throughput and the channel access delay in a saturated network and (b) The delay deviation ratio indicates the rate of increment of channel access delay of a station with respect to the average access delay of the network, and the channel busyness ratio indicates the rate of channel activity due to successful and failed transmissions.

IV. LITERATURE SURVEY

In the year of 2012, the authors "K. Hong, S. Lee, K. Kim, and Y. Kim" proposed a paper titled “Channel condition based contention window adaptation in IEEE 802.11 WLANs", in that they described such as: in IEEE 802.11 standard, the backoff parameters of its collision avoidance mechanism can be very inefficient and hence, the network becomes far from its optimal behavior. There have been several mechanisms to tune the Contention Window (CW) with the aim to achieve the optimal throughput in the IEEE 802.11 WLAN, however, the mechanisms do not specifically address a proper setting of the backoff parameters under nonsaturated conditions. Noting that typical 802.11 networks are usually non-saturated, in this paper, we analytically derive the CW sizes that maximize the WLAN system throughput under both saturated and nonsaturated conditions. Then, using the CW sizes derived, we propose a distributed algorithm that enables each station to dynamically adapt its CW according to the channel congestion status. The performance of the proposed algorithm is investigated through simulation. Simulation results indicate that our proposed backoff algorithm provides a remarkable performance improvement in terms of the delay experienced by a packet in the MAC layer, while maintaining an optimal throughput close to the theoretical throughput limit of the IEEE 802.11 Distributed Coordination Function (DCF) access scheme.

In the year of 2010, the authors "I.Tinnirello and G.Bianchi" proposed a paper titled “Rethinking the IEEE 802.11e EDCA performance modeling methodology", in that they described such as: analytical modeling of the

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802.11e enhanced distributed channel access (EDCA) mechanism is today a fairly mature research area, considering the very large number of papers that have appeared in the literature. However, most work in this area models the EDCA operation through per-slot statistics, namely probability of transmission and collisions referred to “slots.” In so doing, they still share a methodology originally proposed for the 802.11 Distributed Coordination Function (DCF), although they do extend it by considering differentiated transmission/collision probabilities over different slots. We aim to show that it is possible to devise 802.11e models that do not rely on per-slot statistics. To this purpose, we introduce and describe a novel modeling methodology that does not use per-slot transmission/collision probabilities, but relies on the fixed-point computation of the whole (residual) backoff counter distribution occurring after a generic transmission attempt. The proposed approach achieves high accuracy in describing the channel access operations, not only in terms of throughput and delay performance, but also in terms of low-level performance metrics.

In the year of 2007, the author "Z. Fan" proposed a paper titled “Throughput and QoS optimization for EDCA-based IEEE802.11 WLANs", in that he described such as: in IEEE 802.11 standard, the backoff parameters of its collision avoidance mechanism can be very inefficient and hence, the network becomes far from its optimal behavior. There have been several mechanisms to tune the Contention Window (CW) with the aim to achieve the optimal throughput in the IEEE 802.11 WLAN, however, the mechanisms do not specifically address a proper setting of the backoff parameters under non-saturated conditions. Noting that typical 802.11 networks are usually non-saturated, in this paper, we analytically derive the CW sizes that maximize the WLAN system throughput under both saturated and nonsaturated conditions. Then, using the CW sizes derived, we propose a distributed algorithm that enables each station to dynamically adapt its CW according to the channel congestion status. The performance of the proposed algorithm is investigated through simulation. Simulation results indicate that our proposed backoff algorithm provides a remarkable performance improvement in terms of the delay experienced by a packet in the MAC layer, while maintaining an optimal throughput close to the theoretical throughput limit of the IEEE 802.11 Distributed Coordination Function (DCF) access scheme.

V. EXPERIMENTAL RESULTS

The following figure shows the Node formation scheme of the proposed system.

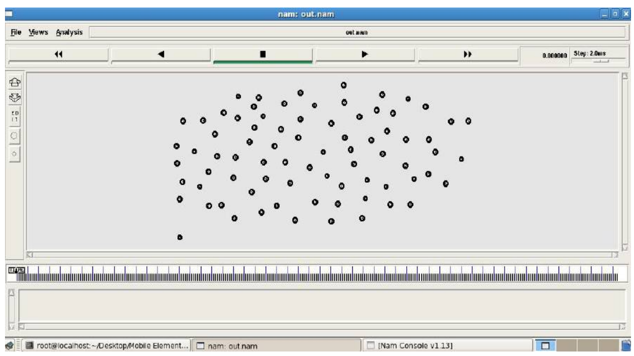

Fig.2 Node Formation

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The following figure illustrates the CH election details of the proposed system.

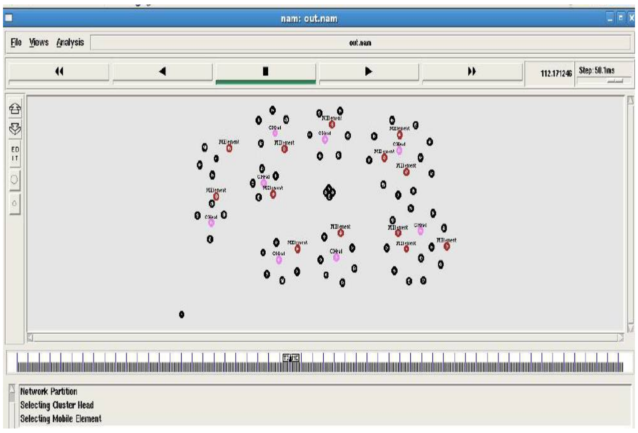

Fig.3 CH Election Details

The following figure illustrates the Communication perception of the proposed system.

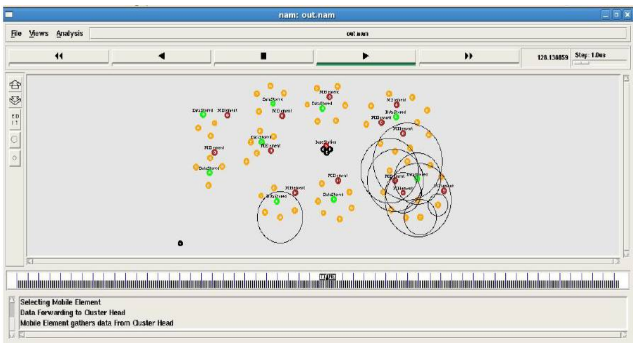

Fig.4 Communication Perception

VI. CONCLUSION

In this system, we proposed a simple and efficient delay aware contention window adaptation scheme, namely D2D, for the performance improvement for both the throughput and channel access delay of a network all together. As the D2D scheme requires the present value of only two ad-hoc, distributed, and estimate parameters related to the network configuration and experienced delay respectively, the scheme is seamlessly integrable with the off-the-shelf hardware of IEEE 802.11e networks. Using the D2D scheme, we designed the D2DCA protocol for the IEEE 802.11e networks. We further proposed a Markov chain model of the proposed protocol for its theoretical performance analysis. Performance evaluation of the D2DCA protocol and the comparison of received results with the three benchmark protocol prove the superiority of the proposed protocol. The comparison with the theoretical throughput limit also proved that under the adequate configuration of protocol parameters, the D2DCA protocol can provide nearly optimal throughput while the average channel access delay is significantly less.

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