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High Throughput MAC Layer CSMA/CA Scheme with Adaptive Contention and Fixed Backoff

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Abstract - The wireless networks is the need of present era of communication for sharing huge amount of data. The wireless network is highly affected with the noises and degrade the performance of the system. Some of the errors are occurred due to the collision of packet during transmission because of the changes in the signal power levels and the number of nodes or workstations in the network. In this paper an efficient CSMA/CA based MAC layer congestion control mechanism is proposed which is based on the minimum contention window considering fixed Backoff timer. After simulation of the proposed congestion control mechanism the highest throughput achieved is 36 Mbps with 5 workstations and the lowest is 20 Mbps with 40 workstations.

Keywords - CSMA/CA, Backoff, Contention Window and Throughput.

I. INTRODUCTION

In the last decade there has been a wide spread deployment of IEEE 802.11 Wireless Local Area Networks (WLANs) which has resulted in an increased demand for various wireless services supporting data, voice, and video which require better quality of service (QoS). In order to meet this demand, the 802.11e medium access control (MAC) with service differentiation has been introduced [1]. The MAC protocol used in IEEE 802.11 WLANs is called distributed coordination function (DCF) [2]. It is a random access scheme based on the carrier sense multiple access with collision avoidance (CSMA/CA) protocol. Since 2000 over 5 billion WLAN (Wi-Fi) enabled devices have been shipped. The number of devices shipped in 2012 exceeded 1.5 billion alone and is expected to exceed 1.9 billion in 2014. This growth is across many markets, including mobile handsets, laptops, media tablets, printers and TVs [3]. The rapid increase in the demand of WLAN enabled devices made the installers typically focus on ensuring the coverage, rather than the capacity or quality of service. Thus, WLAN users usually experience significant performance and reliability issues.

WLAN deployment is considered more complicated than wired network deployment due to the use of radio frequency (RF) links. Each location has its own RF characteristics and thus unexpected radio interference needs to be mitigated. In general, in order to deploy WLANs, five key issues need to be addressed: coverage, capacity, security, mobility and QoS [4]. Many research studies have focused on improving the throughput and delay performance of wireless networks in the context of IEEE 802.11 WLAN. Bianchi in [5] provided an analytical model of saturation throughput performance of IEEE 802.11 that applies to DCF. Since the throughput is considered to be the key factor for efficient WLAN design and planning, this motivated many researchers to develop more accurate approaches to calculate the throughput of WLANs.

In wireless networks, a packet collision does not necessarily mean all the simultaneously transmitted packets are being destroyed. Depending on the relative signal power and the arrival time of the involved packets in the collision, some of these packets can be received successfully if the received power to interference ratio is greater than a certain value, called a threshold. This phenomenon is called the capture effect. In practical WLAN deployments, the capture effect has been shown to enhance the performance of the system throughput and delay performance.

In general, higher capacity WLANs come at the expense of less coverage area of the access point (AP). One of the key parameters that determine the capacity is the minimum association rate between the AP and the stations. The minimum association rate is set to prevent edge users from associating with an AP at low data rates, which results in low overall network capacity. This phenomenon is known as the performance anomaly. The minimum association rate is one of the main parameters that determine the number of APs required from the capacity standpoint.

II. PROPOSED CONGESTION CONTROL MODEL AND SCHEME

The proposed Carrier Sense Multiple Access(CSMA) with Collision Avoidance(CA) scheme in this paper have used following simulation network parameters to perform experiment. The major blocks of the procedure with steps of execution are also explained below in this section.

TABLE I: SIMULATION PARAMETERS

Parameters	Values
Number of Workstations	0-40
Λ	0.05
Physical Layer Data Rate (P)	2×10^{6}
Slot Interval (S)	20×10^{-6}
SIFS	0.5
DIFS	2.5
Avg. Arrival Time	110
Avg. Packet Length	50
Buffer Threshold	$8 \times 10^{6} / (P \times S)$
Contention Window	32
Backoff Time	1000

Whole procedure is performed for the set observation time and the packets are sent over the network with the specified network simulation parameters. All the stations who simultaneously transmitting packets are counted and the packet loss is considered to collision in the network. Now the packet is resent over the network with different time slot.

In a LAN, the number of stations is often small. To make the previous model more realistic, performance analysis under a finite station assumption is conducted by Kleinrock et al. [11]. The modified model is known as the “linear feedback model”.

According to [11], a network consists of a finite number of stations, M. Each station is assumed to be in one of two states – thinking and backlogged. A station that is in the thinking state does not have a data frame to transmit. However, with probability, a new data frame will be generated within a slot. If a data frame is generated, the station will transmit the newly generated data frame in the next slot, otherwise, it will remain in the thinking state. The station will switch to the backlogged state only if the data frame transmission suffers a collision. A station that is in the backlogged state cannot generate further data frames as each station can only carry at most one data frame. It will remain in the backlogged state until it has completed the data frame transmission successfully. The data frame transmission is scheduled for retransmission based on a certain Every time the packet gets transmitted the backoff time decreases by one and after collision the timer get reset to retransmit the packets.

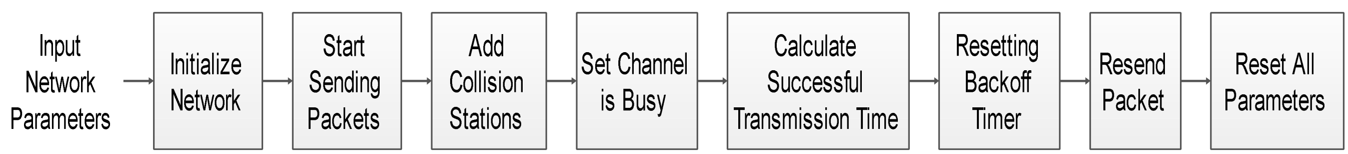

Fig. 2.1 Block diagram of Proposed CSMA/CA System

The proposed minimum contention and fixed Backoff time scheme is explained step by step in the below procedure:

a. *Start of simulation*
b. *Initialize the network parameters*
c. *Start sending packets over network*
d. *Set the backoff counter to 1000 until all the packets are not PUSHed*
e. *Reset after 1000 packets*
f. *Update arrival time and frame length*
g. *Randomly add the conflict station in the sequence*
h. *Checking if channel is busy and the conflict station is only one than it is the normal case of transmission, now set collision to 0.*
i. *If the number of conflict stations are more than one than the collision occurred and then set Collision to 1.*
j. *Now increase the size of contention window as per number of conflict stations.*
k. *Reset Backoff timer*
l. *Go to new transmission of packets*
m. *After transmission calculate Throughput of the proposed scheme*
n. *Display Results and compare throughput with the existing work*
o. *End of simulation*

III. SIMULATION RESULTS

Due to the high demand for QoS differentiated WLANs, the improvement of the throughput and delay performance for CSMA/CA-based WLANs has become more important than ever. Two main research directions have focused on the improvement and the accuracy of calculating the throughput and delay. The first direction was from the pure MAC protocol perspective. The second direction was from the PHY/MAC perspective, where the PHY layer effects are included in the analytical models for more accurate evaluation of the throughput and delay performance of WLANs.

Ad-hoc network is the simplest form of Wireless LAN is a network composed of a few nodes without any bridging or forwarding capability. All nodes are equal and may join or leave at any time, and have equal right to the medium. In fact, it's very much like an Ethernet, where you may add or remove node at discretion. This is the kind of radio networks deployed in homes of small offices.

By definition, the throughput, S, is proportion of time that the channel carries successful transmissions. Consider that data frame sizes are fixed and its transmission time is equal to one unit of time, S is thus equal to the probability that a particular slot carries a successful transmission. To obtain a successful transmission in a slot, it is required to have exactly one transmission, either from the thinking or the backlogged stations.

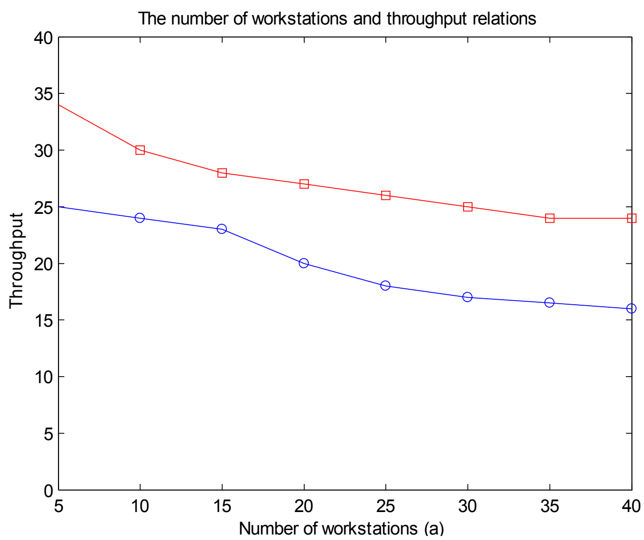

Fig. 3.1 Throughput Performance of the Proposed System

One of the most common metrics used to compare the performances of the various MAC protocols is throughput. This is defined as the ratio of the number of packets arriving successfully at the receiver over the total number of packet transmissions during a set time interval [10]. The throughput S can thus be expressed as:

$$S = p_s \cdot \lambda$$

The model assumes that packet arrivals, in combination with retransmission of packets, follow a Poisson point process with parameter λ and the probability of a successful transmission denoted as p_s the global output of ad hoc networks, i.e. the throughput S, is inherently limited under a vast class of assumptions, i.e., the throughput of the network is dependent on many system parameters and on the restrictions set on the network model that is being used.

IV. Conclusion and Future Scope

The collision control techniques adopted in this paper is working great towards the throughput of the overall system. As the throughput achieved by the previous methodologies is about 25 Mbps maximum on 5 workstations and 16 Mbps minimum on 40 workstations and the proposed methodology achieved is about 34 Mbps maximum on 5 workstations and 25 Mbps minimum on 40 workstations. So it clear that with the adaptive contention window and fixed backoff time system is avoiding the conditions of collision better than other techniques. In future the higher values of the contention window and better collision avoidance techniques with efficient routing approach will definitely increases the throughput of the system.

References

[1] A. Goldsmith, Wireless Communications, Cambridge University Press, New York, 2005.

[2] D. Bertsekas and R. Gallager, Data Networks, Chapter 4, Prentice-Hall, Inc., New Jersey, 1987.

[3] P. Mohapatra and S. Krishnamoorthy, Ad Hoc Networks, Technologies and Protocols, Springer Verlag, New York, 2004.

[4] S. P. Weber, X. Yang, and J. G. Andrews, “Transmission Capacity of Wireless Ad Hoc Networks with Outage Constraints”, IEEE Transactions on Information Theory, vol. 51, no. 12, pp. 4091 – 4102, December 2005.

[5] N. Jindal, J. G. Andrews, and S. Weber, “Optimizing the SINR Operating Point of Spatial Networks”, Workshop on Information Theory and its Applications, San Diego, USA, January 2007.

[6] M. Haenggi, “Outage and Throughput bounds for Stochastic Wireless Networks”, Proceedings of the IEEE International Symposium on Information Theory, pp. 2070– 2074, September 2005.

[7] A. Hasan and J. G. Andrews, “The guard zone in wireless ad hoc networks”, IEEE Transactions on Wireless Communications, vol. 6, no. 3, pp. 897 – 906, December 2005.

[8] S. Weber, J. Andrews, and N. Jindal, “Ad Hoc Networks: The Effect of Fading, Power Control, and Fully-Distributed Scheduling”, in revision for IEEE Transactions of Information Theory.

[9] G. Ferrari and O. Tonguz, “Performance of Ad Hoc Wireless Networks With Aloha and PR-CSMA MAC Protocols”, IEEE Global Telecommunications Conference, San Francisco, USA, vol. 5, pp. 2824 – 2829, December 2003.

[10] P. Gupta and P. R. Kumar, "The Capacity of Wireless Networks", IEEE Transactions on Information Theory, vol. 46, no. 2, pp. 388 – 404, March 2000.

[11] L. Kleinrock and S. S. Lam, "Packet Switching in a Multiaccess Broadcast Channel: Performance Evaluation," IEEE Transactions on Communications, vol. COM-23, no. 4, pp. 410-423, April 1975.

[12] Madan, R.; Sampath, A.; Khude, N., "Enhancing 802.11 carrier sense for high throughput and QoS in dense user settings," Personal Indoor and Mobile Radio Communications (PIMRC), 2012 IEEE 23rd International Symposium on, vol., no., pp.253,259, 9-12 sept. 2012.

[13] Eustathia Ziouva and Theodore Antonakopoulos, "CSMA/CA performance under high traffic conditions: throughput and delay ana'lysis" Computer Communications,29 may 2001.