ISSN 2278 – 0211 (Online)

Grouping in Wireless LANS to Increase Throughput by Collision Control

Shruti Ganapati Hegde
2nd year M.Tech (CNE), Department of Computer science & Engineering
Cambridge Institute of Technology, Bangalore, India
Jayanthi M. G.
Assistant Professor, Department of Computer science & Engineering
Cambridge Institute of Technology, Bangalore, India

Abstract:
A network should be highly scalable i.e. high data rates, high throughput, and low errors. Usage of Wireless LAN's using IEEE 802.11n-2009 standard has increased in the number of stations. As the number of stations increases the path becomes congested and will lead to collisions. The IEEE 802.11n-2009 standard provides a high data rate of 100 Mbps at the physical layer but not that data speed at MAC layer. The techniques like the frame aggregation and block-ACK frames does increase the efficiency at MAC layer but none reduce the collision. Hence collision control is much necessary for achieving high data rates to serve large number of stations. We propose Grouping scheme to reduce the collision rate. Here the stations are grouped and a leader is elected. Only the leaders of respective group contend; which decrease the collision. We compare our simulation results with the DCF with frame aggregation and without frame aggregation.

Key words: *DCF, Frame aggregation, WLANs, MAC*

1. Introduction

The rapid expansion of the wireless local area networks has increased the number of the newer stations to the single access point. Interoperability, mobility, flexibility and cost effective deployment of IEEE 802.11n has made it the most popular wireless network domain [1] [2]. This standard achieves a very high data rate of 100Mbps and even has configurations up to 600 Mbps at the physical layer and expects the same in the medium access control. But the Medium access control layer was designed for low data rates and thus reducing the efficiency. Frame aggregation and Block-ACK frames [3] [4] were used to increase the efficiency of the media access control (MAC). But there are no other schemes in this standard to reduce the collision. This collision is directly related to the station count in the wireless network [5] [6]. Hence it's much necessary to reduce the collision in order to increase the data rates.

We propose a collision control scheme in the MAC using frame aggregation scheme to increase the efficiency. Here the stations are grouped and leader is elected. Only the leader contends with the access point. Since lesser stations contend the number of stations contending with the access point reduces; thus reducing the collision. Simulation and analytic results were used to evaluate the performance of this grouping scheme. Simulation results shows that this provide a good increase in throughput and low collision

2. Related Work

2.1. IEEE 802.11 n PHY

The IEEE 802.11 PHY layer performs a simultaneous job of concentrating on the wireless transmission and assessing the state of the wireless medium and updating the state to the MAC layer. Due to the rapid increase in the users demand for high speed wireless network and increase in the number of users; there has been an improvement in the PHY layer i.e. the present 802.11 n WLAN has a data rate of 100Mbps at the PHY by using the Multi- input Multi-output (MIMO). In spite of the techniques the throughput at the MAC layer has been low, leading to the low data rate. [7].

2.2. IEEE 802.11 MAC

MAC layer is an interface between the Logical Link Control (LLC) and the PHY .MAC widely uses the Distributed Coordination Function widely using CSMA/CA. But it was found that the this DCF technique could not provide the high data rate as the physical layer of 100 Mbps instead could only provide a data rate which is only 50% of the physical data rate i.e. around 25Mbps [8]. The standard uses the block ACK which aggregates the ACK frames which are to be sent to the recipient. There are two types of Block ACK .The Immediate Block ACK frame sends a number of data frames followed by the Block ACK Request frame followed by the reply from the recipient after SIFS duration. The Delayed Block ACK the number of data frames to be received for the acknowledgement is specified. After receiving the particular number of frames the recipient replies with the acknowledgement after TXOP. The transmission can also be done in both ways using the reverse direction protocol.

3. Proposed Work

In this section we present in detail the Node grouping in MAC to increase throughput.

3.1. The Scheduling Frame

The scheduling frame Figure 1 distributes the schedule among the nodes of the group. It's the duty of the leader to send this scheduling frame whenever it gets an access to the channel.

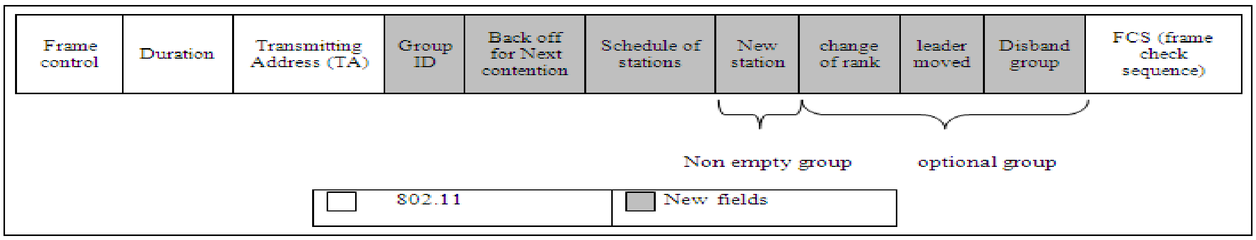

Figure 1: Scheduling frame

3.2. Grouping of Stations

WLANs have large number of stations connected to a single access point. These stations are grouped and care is taken so that no hidden nodes are present. When a new node enters into the network it first estimates the distance from it to the leader for a particular period of time. The node joins the group which is at a distance of D/2 where D is the communication distance. If there are several leaders present within the distance of D/2 then the node selects the nearest group. Later new node sends a request to the access point indicating the name of the group it wants to join. The access point then sends the confirmation for its request to join the group. The group leader decodes this association frame and assigns a rank to the station. Next the group leader transmits the scheduling frame indicating the ranking and MAC address of the new station Figure 2.

If the new station finds that there are no group leaders within distance of D/2 then it assigns a group ID -1 indicating in the association request frame that there are no groups to join. The access point then assigns a new group ID to the node indicating that new node start its own group ad becomes it leader.

3.3. Transmitting

The leader assigns the schedule for each node in its group and this schedule is stored in the scheduling frame. When the leader gets its turn to transmit the data it aggregates its scheduling frame in A-MPDU to the data frame. The stations then transmit the data one after the other with a SIFS duration gap between them. Here since there are no hidden nodes in the network there is no need for RTS/CTS exchange.

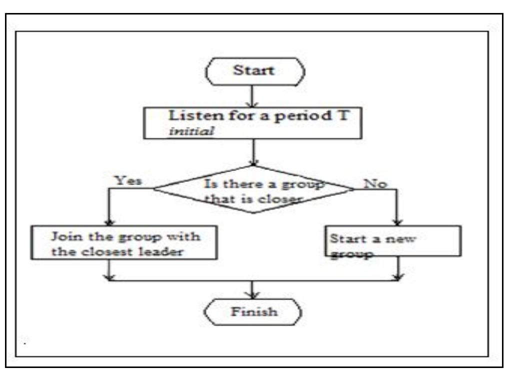

Figure 2: procedure for grouping

4. Analysis

We show the benefit of grouping of the stations in reducing the probability of collision. The analysis compares the through put with our scheme grouping and normal MAC scheme using DCF.

4.1. Performance

Let n stations contend using DCF over time duration *D* and *d* data frames. Then *s (n, d, D)* gives the number of successful transmissions.

In our scheme, consider *n* stations and are divided into *g* equal groups. Every station transmits d data frames on access. As the number of contending station is g the number of data frames transmitted after each contention is (n/g).d. The performance gain compared over DCF is

p= s (g (n/g, d, T)/s (n, 1, T).The normal DCF schemes time utilization [10] is given by

$$C = Ps.Pr.\frac{Tpayload}{((1-Pr)S+Pr.Ps.Ts+Pr.(1-Ps).Tc)} \quad (1)$$

In this equation the Pr is the probability that the station transmits and Ps is the probability of successful transmission, Ts is time for successful transmission, Tc is the time for collision event and S is time for back off slot.

The expression for Pr and Ps is given by

$$Pr = 1-(1-r)^n \quad (2)$$

$$Ps = n.\frac{r(1-r)^{(n-1)}}{Pr} \quad (3)$$

Where

$$r = \frac{2(1-p)}{(1-2p)(CWmin+1)+p.CWmin((1-2p)^{m})} \quad (4)$$

5. Simulation Results

The following section presents the simulation results which compare the normal MAC and our grouping scheme. We first calculate the collision rate in both normal MAC and group MAC.

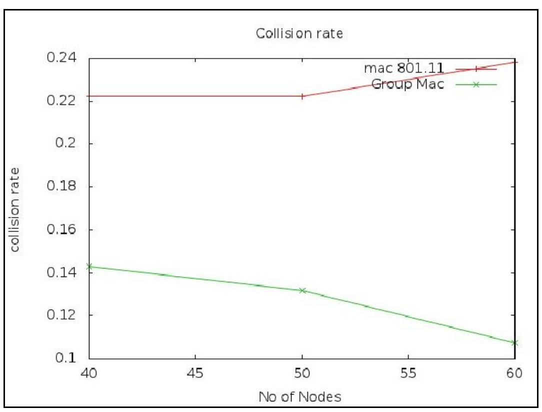

Figure 3: Collision with 50 nodes

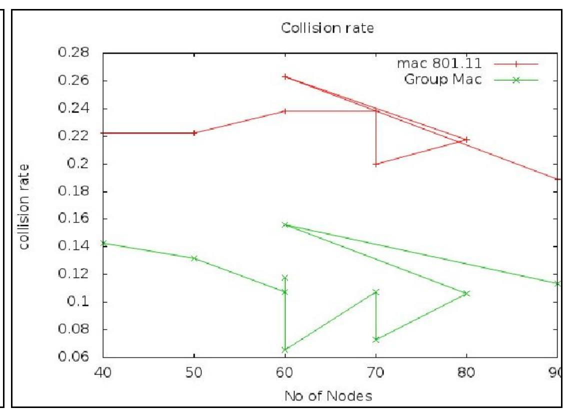

Figure 4: collision with 60, 70, 80 nodes

The Figure 3 and Figure 4 show the collision in both normal MAC and the collision after grouping. It's clear that the normal MAC has higher collision rate than the grouping scheme. Similarly the throughput of both the normal and group were compared

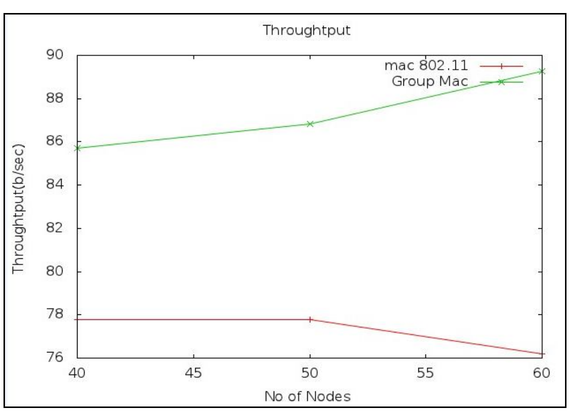

Figure 5; Throughput with 50 nodes

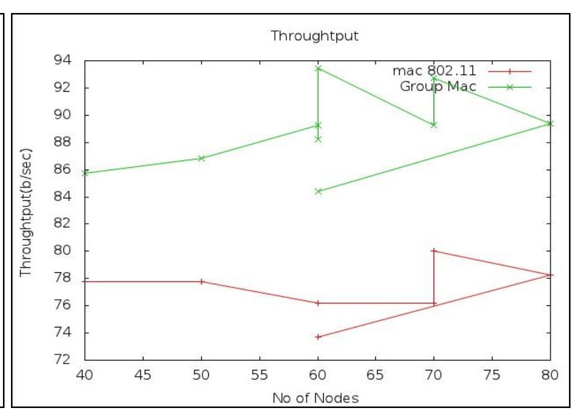

Figure 6: Throughput with 60, 70, 80 nodes

It was found that (from Figure 5 and Figure 6) the throughput after grouping the nodes increased. It was also found that increase in the number of nodes did not decrease the throughput of grouping scheme than normal.

6. Conclusion

The normal MAC scheme had a high collision rate with the increasing demand for WLANs leading to increase in number of incoming stations. The grouping of stations led to the decrease in the collision rate hence increasing the throughput at the MAC layer. It was found that the collision rate was much less when compared to normal MAC which uses a DCF scheme. Increase in the number of nodes did not decrease the throughput of grouping scheme than normal.

7. References

1. Zakhia Abichar and J. Morris Chang," Group-Based Medium Access Control for IEEE 802.11n Wireless LANs", IEEE transactions on Mob comp, vol. 12, Feb. 2013.
2. E. Perahia, "IEEE 802.11n Development: History, Process, and Technology," IEEE Comm. Magazine, vol. 46, no. 7, pp. 48-55, July 2008.
3. Y. Xiao, "IEEE 802.11n: Enhancements for Higher Throughput in Wireless LANs," IEEE Wireless Comm., vol. 12, no. 6, pp. 82-91, Dec. 2005.
4. B.S. Kim, H.Y. Hwang, and D.K. Sung, "Effect of Frame Aggregation on the Throughput Performance of IEEE 802.11n,"Proc. IEEE Wireless Comm. and Networking Conf. (WCNC), pp. 1740-1744, Mar. 2008.
5. T. Li, Q. Ni, D. Malone, D. Leith, Y. Xiao, and T. Turletti, "Aggregation with Fragment Retransmission for Very High-Speed WLANs," IEEE/ACM Trans. Networking, vol. 17, no. 2, pp. 591-604, Apr. 2009.
6. G. Bianchi, "Performance Analysis of the IEEE 802.11 Distributed Coordination Function," IEEE J. Selected Areas in Comm., vol. 18, no. 3, pp. 535-547, Mar. 2000.
7. Y. Yuan, W.A. Arbaugh, and S. Lu, "Towards Scalable MAC Design for High-Speed Wireless LANs," EURASIP J. Wireless Comm. and Networking, vol. 2007,
8. Y. Xiao and J. Rosdahl, "Throughput and Delay Limits of IEEE 802.11," IEEE Commun. Letters, vol. 6, no. 8, Aug. 2002, pp. 355–57.
9. Q. Ni et al., "AFR partial MAC proposal for IEEE 802.11n," IEEE 802.11n working doc. 802.11-04-0950- 00-000n, Aug. 2004.
10. Y. Yuan, W.A. Arbaugh, and S. Lu, "Towards Scalable MAC Design for High-Speed Wireless LANs," EURASIP J. Wireless Comm. and Networking, vol. 2007