Cross Layer Service Driven Adaptive Retry Limit for IEEE 802.11 Mobile Ad-Hoc Networks

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***Abstract* - Traffic in future Mobile Ad-Hoc Network (MANET) is expected to carry a mix of real time multimedia, and non real time file transfer etc. Providing Quality of Service (QoS) for these different applications is difficult and the current research on MANET is choosing the Cross Layer Design for providing QoS. The packet loss due to collision is misinterpreted by MANET as route failure and this triggers route maintenance phase causing unnecessary overhead resulting in low throughput. In this paper, we propose a service driven cross layer model in order to increase the throughput by dynamically adjusting the limits of Request to Send (RTS) retransmission for different flows in the network according to the priority. Simulation is done in NS-2 and the proposed method is compared with IEEE 802.11 DCF MAC using two ad-hoc routing protocols namely AODV and DSR. The results show that the prioritized flow achieves higher throughput over un-prioritized flow when compared to IEEE 802.11 MAC.**

Key Words: MANET, CLD, RTS/CTS, SRL, QoS, service driven.

I. INTRODUCTION

Mobile Ad-Hoc Networks (MANETs) are self-organizing, dynamically reconfigurable and rapidly deployable networks, which do not require fixed infrastructure. Mobile nodes (MNs) in ad-hoc network environment play a dual role, as a host and as a router at the same time and MNs communicate with each other through intermediate nodes. Future MANETs provide all kinds of traffic covering from voice to video, from real time to non real time services. Hence, providing QoS for these different types of traffic is difficult and challenging task. MANETs are rapidly gaining popularity due to its network architecture which is very useful in disaster recovery, military applications, emergency warnings etc. However, MANETs suffer from heavy contention resulting in significant degradation in throughput [1]. This reduced throughput is due to misinterpretation of the packet loss as link failure whenever collision occurs. Hence, the source node may assume that the destination node is no longer reachable and this phenomenon is referred to as False Route Failure (FRF). This FRF triggers the route maintenance phase for re-discovery of the route even though the actual route is still active. The route discovery phase is a complicated process in terms of time and network load and eventually reduces the overall throughput of the MANET. Several attempts [2-4] have been made in order to control FRF and to minimize the collision. M. Gunes et al [2] have proposed an adaptive RTS/CTS retransmission scheme “Dynamic Short Retry Limit (DSRL)” for reducing the collision loss in MAC layer in which Short Retry Limit (SRL) can be adjusted dynamically by using the history of the previous packets. K. Nahm et al [3] proposed DAMPEN, a cross layer approach among MAC and Network Layer to reduce the FRF; but, DAMPEN responds only to bulk losses. Apart from this, K. Nahm et al [4] have addressed that TCP’s burst traffic overloads the MANET which leads to frequent collision and they have also proposed a Congestion Window limit in a TCP sender in order to avoid the network overloading.

Vijay T. Raisinghani and Sridhar Iyer [5] have concluded that the existing layered protocol stack functions inefficiently in mobile wireless environment due to highly variable and the limited nature of the mobile devices. Cross Layer Design is receiving tremendous attention among the researchers for increasing the efficiency of mobile wireless networks. Vineet Srivastava et al [6] have defined the Cross Layer Design as “a protocol design by violating the reference layered architecture” for accessing the information across the protocol stack.

In this paper, we propose a service driven cross layer model in order to increase the throughput by dynamically adjusting the limits of Request to Send

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(RTS) retransmission for different flows in the network according to the priority. This cross layer model uses Upper to Lower Layer for providing the differentiated services among the flows in the MANET. The rest of the paper is organized as follows: Section 2 deals with IEEE 802.11 DCF MAC; Section 3 discusses the proposed model; Simulation Environment is explained in Section 4 followed by Results and Discussion in Section 5 and the Conclusion in Section 6.

II. IEEE 802.11 DCF MAC

The IEEE 802.11 MAC uses Distributed Coordination Function (DCF) in order to share the medium among multiple contenders. However, IEEE 802.11 DCF MAC does not work well in multi hop environment due to hidden node problem. Hence, RTS/CTS mechanism is introduced in DCF to avoid the hidden node problem. But still, collisions cannot be avoided by RTS/CTS scheme due to the interference problem.

In ad hoc networks collision occurs more often and whenever an RTS packet collides, the sender retransmits another RTS packet and the number of RTS retries is limited to number of SRL times (the default value of SRL is 7). In a static topology the packet loss is due to collision and it is very difficult to classify the packet loss either as the collision loss or the mobility induced loss.

III. PROPOSED MODEL

(a) Cross Layer Design

The priorities for the application are accepted by the Application Layer and through the Shared Registry the Application Layer will inform the other two lower layers about the type of services to be given to the different flows.

(b) Dynamic Retry Limit

As soon as a node receives the packets, the network layer checks for the priority of the packets and accordingly informs the MAC layer to adjust the Short Retry Limit (SRL). S Kim et al [7] have shown that the SRL value of 30 yields the maximum overall throughput and for greater than 30, the throughput gets saturated.

In the proposed method, we considered SRL value of 30 for the packets with higher priority by dynamic adjustment at the MAC layer i.e. a node will try for 30 RTS retransmissions before dropping a packet and triggering a route maintenance phase. For the un-prioritized packets the default SRL value is set (SRL=7) and will not be changed.

IV. SIMULATION ENVIRONMENT

Simulation has been carried out to evaluate the proposed model using NS-2 [8]. In the simulation, the IEEE 802.11 DCF is used as the MAC layer protocol and the data rate of wireless channel is fixed at 2Mbps. 100 nodes are randomly distributed and move randomly following the random waypoint mobility model with the mobility of 2 m/s across 1000 x 1000 meters. Each node has a transmission range of 250 meters.

Two experiments namely 1) Static Prioritized SRL (S.SRL) and 2) Dynamic Prioritized SRL (D.SRL) were conducted using two flows F1 and F2, where priority is given to F1 over F2 throughout the simulation. For S.SRL, priority is assigned at the beginning of the data flow and the same priority is kept till the end of the simulation. For D.SRL, both the flows start with equal priority and in the middle of the session, the priority is given to F1 dynamically. In our simulation, we have considered both the flows with equal priority up to 300 seconds (in Experiment 2 it is 200 sec) and after 300 sec the priority is given to F1 over F2.

V. RESULTS AND DISCUSSION

Two experiments were conducted with two on-demand ad-hoc routing protocols namely (a) AODV and (b) DSR. The experiments are explained below.

5.1 Experiment 1: Simulation using AODV

The throughput comparison of IEEE 802.11 DCF MAC and S. SRL is shown in Figure 1 and it is clearly observed that the throughput of F2 dominates over F1 in IEEE 802.11 DCF MAC.

On the other hand, S. SRL achieves good throughput with F1 of higher priority and its throughput is almost doubled; further, F2 has low throughput due to the higher priority of F1.

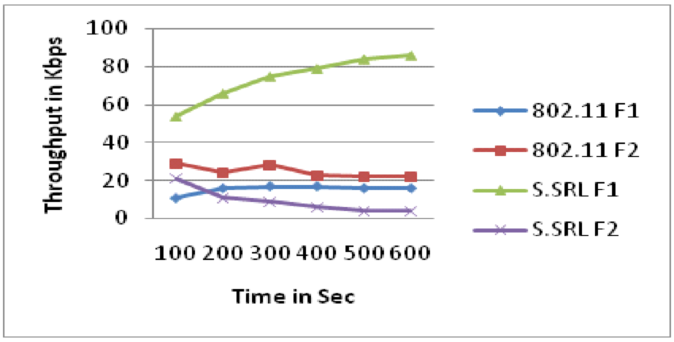

Figure. 1. Throughput comparison of IEEE 802.11 Vs S.SRL

This is mainly due to the increased value of SRL (30) for F1 and there is a higher probability of channel occupancy by F1 for most of the simulation time. Figure 2 shows the behavior of D. SRL. It clearly shows that the throughput of both IEEE 802.11 DCF MAC and D. SRL is almost same up to 300 seconds; further, F1 yields higher throughput when compared to F2 after 300 seconds.

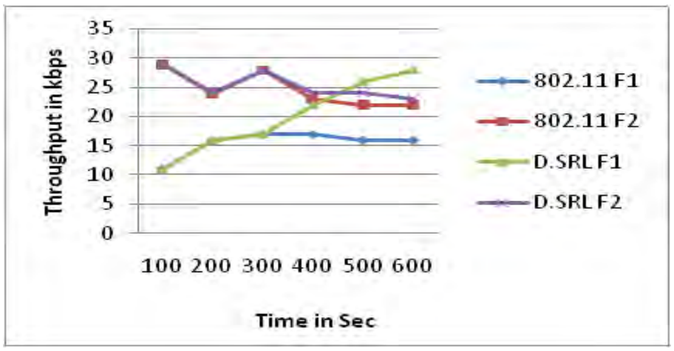

Figure. 2. Throughput comparison of IEEE 802.11 Vs D.SRL

5.2 Experiment 2: Simulation using DSR

The experiment results show that the behavior of DSR is very much similar to AODV since working conditions of both the routing protocols are almost similar. The same justification with respect to results of AODV holds good for DSR and the corresponding results are shown in Figures. 3 and 4.

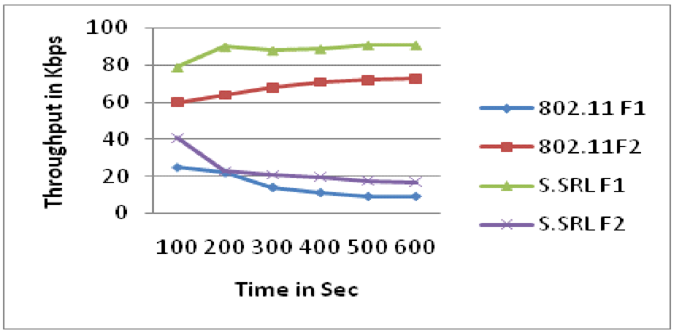

Figure 3. Throughput comparison of IEEE 802.11 Vs S.SRL

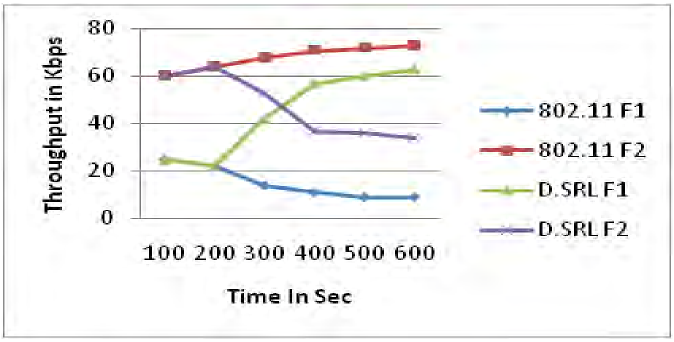

Figure. 4. Throughput comparison of IEEE 802.11 Vs D.SRL

VI. CONCLUSION

In this paper, we proposed a service driven cross layer model for providing QoS to different flows running in the network. The limit of RTS retransmission is adjusted dynamically according to the priority of the flows where the priority is accepted by upper layers and it is shared with the lower layers. Two different scenarios were used to study the new model, by giving the priority right from the beginning of the session to the end of the session and by dynamically assigning the priority to the flow during the middle of the session. Simulation results have demonstrated that the proposed method improves the throughput when compared to IEEE 802.11 DCF MAC.

REFERENCES

[1] S. Xu and T. Saadwi ," Does IEEE 802.11 MAC protocol work well in Multihop wireless Adhoc networks?",IEEE communications magazine, vol.39, no.6, 2001.

[2] M. Gunes, M. Hecker and I. Bouazizi , " Influence of adaptive RTS/CTS retransmission on TCP in wireless and ad-hoc networks", proceedings of the 8th IEEE international symposium on computers and communications (ISCC'03), Antalya,Turkey, 2003, pp. 855- 860.

[3] K.Nahm, A Helmy and C.-C.J. Kuo , " Improving stability and performance of multihop 802.11 Networks ",in proceedings of ACM International symposium on Mobile AdHoc Networking and Computing (MOBIHOC'05) Urbana – Campaign, Illinios, May 2005.

[4] K.Nahm,A.Helmy, and C.-C.J. Kuo, "TCP over multihop 802.11 networks: issues and performance enhancement", proceedings of ACM international symposium on Mobile ad hoc networking and computing (MOBIHOC'05), Urbana – Campaign, Illinios, May 2005.

[5] Vijay T. Raisinghani, Sridhar Iyer ,"Cross-layer design optimization in wireless protocol stacks", Elsevier , 2004.

[6] Vineet Srivastava, Mehul Motani, " Cross Layer Design : Survey and the road ahead",IEEE communication magazine, Vol. 43, Issue 12, pp. 112-119, December 2005

[7]Sehoon Kim, Jinkyu Lee and Ikjun Yeom " Neighbour-aware Adaptive Retry Limit for IEEE 802.11 based Mobile Ad Hoc Network", Wireless Communication and Networking Conference (WCNC-2008) , IEEE, 2008, pp. 1402 – 1407

[8]"The Network Simulator - NS-2 ", http://www.isi.edu/nsnam/ns