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Performance Model for Campus Area Network based on MAC Protocol

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Abstract: The routing simulations over ad hoc networks indicate that network capacity is poorly utilized in terms of throughput and packet delay when the 802.11 MAC protocol is integrated with routing algorithms. Also, since wireless network access point is open to anyone, problem of security is inherent in wireless scenario. In this paper we aim to study the characteristics & performance of MAC Layer with regard to IEEE 802.11 MAC protocol and 802.3 MAC protocol from the point of view of Campus Area Network. We conducted some simulation for the same using NS- 2 and concluded an adaptive performance model best suited for University Campus Area for networking in terms of throughput and fairness. We created a performance model of Wireless local area network to show what happens when large no. of mobile nodes take part, move and communicate with one another in a WLAN and simulated our model taking varying slot time from 20 to 15, 12 & 10 micro sec. for getting optimum key point for such WLANs.

Keywords: IEEE 802.11, WLAN, MAC, NS-2, IEEE 802.3

I. INTRODUCTION

A. MAC (Media Access Control):

The 802.11 family uses a MAC layer known as CSMA/CA (Carrier Sense Multiple Access/Collision Avoidance) while Classic Ethernet uses CSMA/CD - collision detection). CSMA/CA is, like all Ethernet protocols, peer-to-peer; there is no requirement for a master station.

IEEE 802.11 MAC protocol has been the standard for Wireless LANs, and also adopted in many network simulation packages for wireless multi-hop ad hoc networks while IEEE 802.3 MAC protocol had been standardized for Wired LAN. In ad hoc networks, communications are done over wireless media between stations directly in a peer to peer fashion without the help of wired base stations or access points. A wireless network access point is open to anyone within range and having proper equipment. If the router or access point is configured to distribute IP addresses via DHCP (Dynamic host configuration protocol), anyone equipped with a wireless enabled laptop or PDA can use it freely. So, security is the main concern in wireless networks. Older wireless routers/access points have two basic security methods: MAC address filtering and Wired Equivalent Privacy (WEP). Both MAC and WEP offer only very basic security. Even newer versions of wireless routers/access points make use of 2 additional security methods. The first is the Wireless Application Protocol (WAP), of which there are several variations. A router/access point may also support the Remote Authentication Dial In User Service (RADIUS), a protocol that works in conjunction with Network Operating Systems such as Windows, UNIX or Linux servers and is used for larger networks. But yet a lot of security measures are required to be done.

B. Slot Time:

Slot time is the time it takes for a packet to travel the Performance Model for Campus Area Network based on MAC Protocol maximum theoretical distance between two nodes in a network. Collision detection protocols always wait for a minimum of slot time before transmitting; allowing any packet, that was being sent over the channel at the same time at which the waiting node requested to send, to reach the waiting node. If the slot time were set to a small value, it would mean that the nodes waiting to send a packet would wait for a small time before transmission and if the slot time were set to a large value, it would mean that they would have to wait for a longer period of time. Smaller slot time would mean more collisions while longer slot time would mean lesser collisions but waiting for an unnecessarily long period of time. Therefore, setting the slot time to an optimum value is important.

II. RELATED WORK

Many papers have been published relating to performance of wireless LAN based on Mac protocol in which probability distribution of the MAC layer packet service time (i.e., the time interval between the time instant a packet starts for transmission and the time instant that the packet either is acknowledged for correct reception by the intended receiver or is dropped) has been characterized (e.g. [2]) and performance evaluation of DCF vs. EDCF has also been done (e.g. [6]).

Different types of traffic such as video, voice and data has been taken into account that means performance evaluation DCF vs. EDCF has been done (e.g. [6]).Paper on Quality of Service parameters (QoS) for IEEE 802.11 has also been published by different authors (e.g. [2], [6], [7]). However improved Performance of wireless LAN has been thought and simulated by improving the MAC from IEEE 802.3 to IEEE 802.11 but, to the best of our knowledge, no one thought to create a Model particularly for University Campus Area or area which comes in between the Wired Local Area Network and Wide Area Network. So we created a Performance Model for Campus Area Network based on MAC Protocol, by varying slot time (e.g. [1]) to see the optimum point where the model performance would be the best in terms of throughput and delay.

III. EXPERIMENTAL SETUP

The simulation experiment is carried out in LINUX (Ubuntu 9.04). The detailed simulation model, based on network simulator-2 (ver-2.33), is used in the evaluation. The NS instructions can be used to define the topology structure of the network and the motion mode of the nodes, to configure the service source and the receiver, to create the statistical data track file and so on.

IV. TESTING AND ANALYSIS

We created the model using Mac protocol IEEE 802.3 and IEEE 802.11 in peer to peer fashion and concluded that throughput of 802.3 Mac is always better than 802.11 MAC (Figure1).

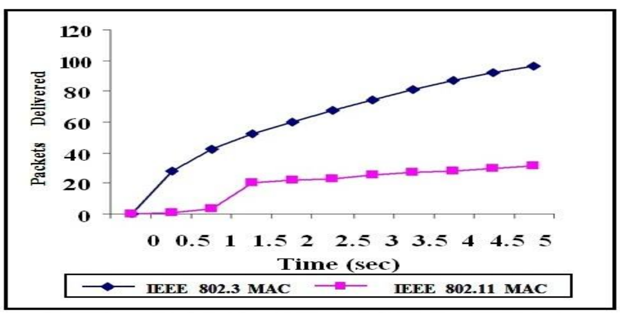

Figure 1. Throughput comparison of IEEE 802.3 & IEEE 802.11 MAC Protocols

To confirm our results, we created another model with increased no. of nodes and varied packet size. The simulation time, no. of nodes, packet size and traffic type were same for both IEEE 802.3 Mac and IEEE 802.11. Figure 2 supports the conclusion drawn above where throughput for IEEE 802.3 was more as compared to that of IEEE 802.11.

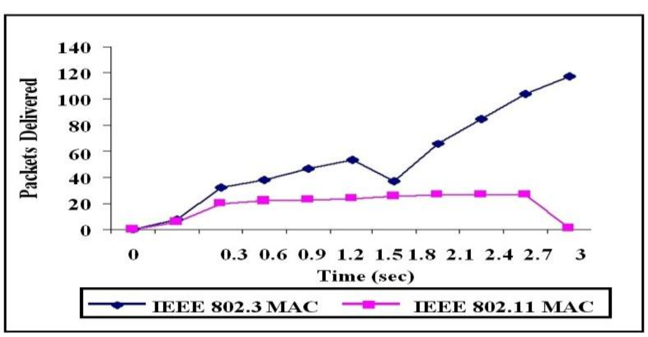

Figure 2. Throughput comparison of IEEE 802.3 & IEEE 802.11 MAC Protocols in varied scenario.

In both the scenarios, IEEE 802.3 out performs IEEE 802.11 in terms of throughput. So, we can say that IEEE 802.3 MAC Protocol is more effective for a Campus Area Network than IEEE 803.11 MAC Protocol.

Now we created a Performance Model, suited for University Campus Area, a typical scenario of a classroom or a conference hall, where each person is equipped with a lap top. Different parameters were taken as follows:

Table I. Experimental Setup for Performance Model

Number of nodes	100-scene1, 50-scene 2
Pause Time	2 sec
Moving max. speed	10.00 m/s
Topology Boundary	Max X: 500.0, max Y: 500.0
Send Rate	0.375939849624060l3
Max. connection	40
Total source/connections	25/40

We simulated our performance model by varying slot time from 20 micro sec to 15, 12 & 10. The graph below shows the delay for two different scenarios, having 100 and 50 nodes.4

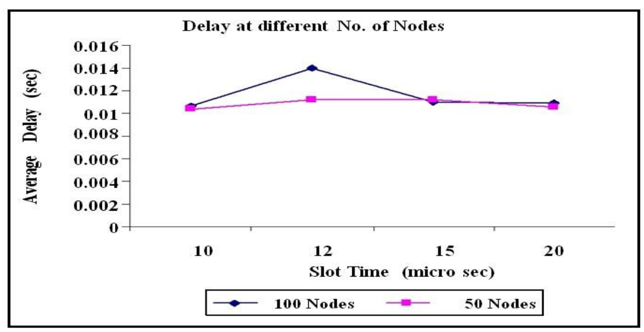

Figure 3. Delay at different NN

Figure 3 shows that the delay at 10 micro sec is lowest for both the scenarios but this conclusion is not of any use until and unless we compare our result with average throughput.

Throughput values corresponding to different delay for both the scenario, viz. 50 nodes and 100 nodes, gave almost same results. The following graph shows the combine result of throughput and average delay with varied slot time:

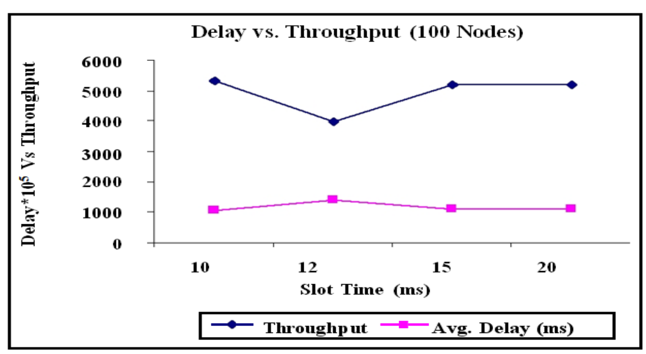

Figure 4. Throughput vs. end to end delay for 100 Nodes

The result shows that average delay at 12 micro sec. is highest and throughput is lowest. That means slot time cannot be considered altogether at that time. At 20 & 15 Micro sec. there is close competition where the difference of both delay and throughput is very less .The lowest delay in our result is at 10 micro sec. but throughput is not highest. It has low throughput than throughput at 20 as well as at 15 micro-sec. Highest throughput is at 15 micro sec. It seems that the optimum point is at either 20 or 15 micro sec. But when we compare the result by taking the delay equal to all in per thousand, the picture becomes clear and we get the optimum point which is 10 micro sec for our performance model.

Same comparison was also performed for 50 nodes. The optimum point obtained in this case is also 10 micro sec, where average delay is lowest.

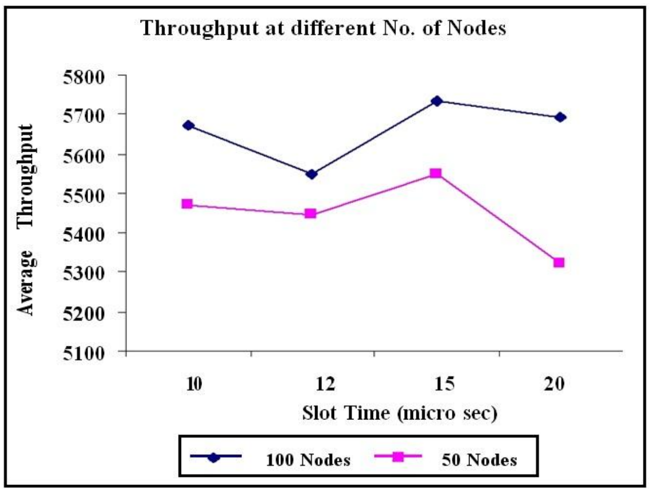

Figure 5. Throughputs vs. end to end delays for 50 nodes

Figure 5 confirms the results obtained from the scenario where we used 100 nodes.

Average throughput values for the two different scenarios shows the same result in both the cases. Throughput for IEEE 802.3 is always more as compared to IEEE 802.11. Comparison in figure 6 shows that IEEE 802.3 gives better performance than IEEE 802.11in terms of throughput.

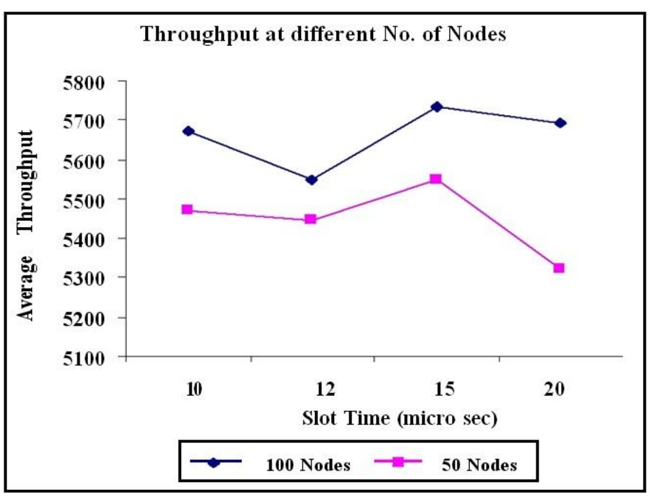

Figure 6. Throughput at different NN

V. CONCLUSION

Through this paper we aimed to know the performance of Mac Protocol in three different aspects keeping in mind the three different versions of Mac Protocols, standardized and specified by the IEEE. Firstly we evaluated and examined the IEEE 802.3 MAC protocol. Secondly we took for examination IEEE 802.11 MAC protocol that has been standardized for wireless LAN. We conducted simulation keeping in the mind the Campus Area Network and concluded that IEEE 802.3 Mac Protocol can be more effective than 802.11. The reason is clearly drawn theoretically that wired nodes which are taking parts in the network are stationeries. The network is therefore static in nature. While wireless nodes are mobile or moving as well as stationery and the topography of wireless network keep on changing that means they are dynamic in nature. That is why throughput of wired network is always better than the wireless one. So, if we ignore the one time heavy investment in setting up fiber optic wired network at University Campus, on one hand, we would be able to solve the problem of security which is inherent in the wireless scenario and on the other hand, we would also get higher throughput.

VI. FUTURE WORK

There are other points of consideration which make 802.11 more effective than 802.3. To make the Mac Protocol more effective, IEEE standardizes 802.11e on November 2003, which differentiates traffic such voice, video and data. The voice, video are delay sensitive and data is understood delay tolerant while IEEE 802.11 MAC provides equal access of channels for all types of traffic. Besides there are other problems of 802.11 Mac protocol such as packet delay and packet drops when traffic goes up resulting in poor utilization of n/w capacity. So IEEE 802.11e may also be evaluated and examined comprising with IEEE 802.11 in near future. That is Why IEEE 802.11e has been kept in third Category, a lot of work on which has been done that deals with the Quality of Service. A lot of work can be done using it.

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