Random Access Career Sense Protocol: A Comparative Analysis of Non Persistent and 1 Persistent CSMA

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Abstract:- In this paper we discussed the simulation based comparative analysis of two random access carrier sense protocol ie. Non persistent CSMA and 1 persistent CSMA in wireless network taking considering of random back off algorithm. The feedback comparison of both protocols compared with respect to load on medium utilization and average waiting time. Both results are demonstrated in different load conditions.

Keywords:- *Wireless Networks, Network utilization, LAN, Protocol analysis, Performance evaluation, Multiple access, CSMA.*

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I.   Introduction

We can differentiate wireless networks in to two broad standards i.e. Infrastructure and ad hoc. An infrastructure wireless network refers to wireless stations connected to a wired network via access units or wireless hubs much like workstations being attached to a backbone network via a hub in a wired LAN. An ad hoc network is a collection of wireless mobile hosts forming a temporary network without established centralized administration or other infrastructure.

An important function of wireless networks is to extend access to the present wired infrastructure. This is practical only through extension of seamless wireless network. The 802.11 protocol is part of the IEEE 802 family of standards which allows for seamless integration between various members of the IEEE 802 family such as Ethernet (802.3) and Token Ring (802.5) [1].

The medium access control (MAC) portion of the IEEE 802.11 protocol, called the Distributed Foundation Wireless Medium Access Control (DFWMAC), is based on the carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) mechanism with a rotating back off window. Due to the limited bandwidth offered by wireless radio frequency network, collisions pays much on a wireless system than a wired network. The Collision than the Carrier Sense Multiple Access with Collision Detection (CSMA/CD) mechanism used by Ethernet, but collisions can and do occur [9].

A contention based scheme is essentially used to devise algorithms that solve the collision once they occur, so messages can successfully transmit. There are two types of conflict resolution algorithms that are adaptive and non adaptive (say static). Static resolution can be deterministic in nature if fixed priority to the nodes is assigned, or it is probabilistic in nature

as it done in ALOHA type schemes and other various CSMA schemes. The adaptive schemes attempt to track the system evolution process and use the available information. As we assume that resolution can be based on arrival time, prioritized to transmission as highest or lowest by any tree base algorithms. On other side resolution can be probabilistic and can change strategy dynamically according to extent of interference. most common example of this scheme is exponential back-off scheme for Ethernet for Estimating the multiplicity of the interfering nodes. Note that when the population of potential nodes in the system increases beyond a certain amount and conflict-free schemes are useless, contention based protocols are the only possible solution [8].

This dissertation report evaluates the performance parameters, namely, medium utilization and average waiting time per packet for IEEE 802. 11 CSMA/CA. Data frames are assumed to be the maximum allowed size, i.e. (18,704 bits) for MAC portion of IEEE 802.11. It is further assumed that the higher level layers of the model deliver farms for transmission with a poison distribution (exponential inter-arrival times) [2].

Our observation presented the Performance of Distributed polling Service-based Medium Access Control. We studied the problem of improving the efficiency of MAC protocols. we first analyse the popular non Persistent CSMA scheme and shown that it does not achieve a cent percent throughput . Many MAC protocols have been proposed over the years for wireless networks, such as ALOHA, Slotted ALOHA, carrier sense multiple access (CSMA) (with several versions), and CSMA with collision avoidance (CSMA/CA). The CSMA/CA-like IEEE 802.11 MAC has become the most popular protocol for single or multi-hop wireless networks. In this research they studied the problem of improving the efficiency of type of wireless MAC protocols that is non persistent CSMA and 1

persistent CSMA. For simplicity, they first consider a single-hop ad hoc network, where all nodes can hear and directly communicate with each other, and then discuss how to extend their work to multi-hop wireless networks. They examined the reservation-based p-Persistent CSMA scheme (called p-Persistent CSMA in that paper), which uses RTS/CTS for contention resolution and p-Persistent carrier sensing when sending RTS frames. Our observation scheme differs from other standard protocol i.e. IEEE 802.11 protocol only in the selection of the back off interval. In this paper instead of binary back off exponential back off interval sample is used from an arithmetical sharing with limitation of p used.

II. IEEE 802.11 CSMA

The first carries sense protocol we will study here is called 1-persistent CSMA (carrier sense multiple access). When a station has data to send, it first listens to the channel to see if anyone else is transmitting at the moment. If the channel is busy, station waits until it become idle. When the station detects an idle channel, it transmits a frame. If a collision occurs, the station wait a random amount of time and starts transmits with probability of 1 whenever if finds the channel idle.

The propagation delay has an important effect on the performance of the protocols, there is a small chance that just after a station begins sending, another station will become ready to send and sense the channel. If the first station's signal has not yet reached the second one, the second channel will sense channel idle and will also being sending continuously, resulting in a collision. The longer the propagation delay, the more important this effect becomes, and the worse the performance of the protocol

Even if the propagation delay is zero, there will still be collisions. if two stations become ready in the middle of a third station's transmission, both will wait politely until the transmission ends and then both will begin transmitting exactly simultaneously, resulting in a collision. If they were not so impatient, there would be fewer collisions. Even so, this protocol is far better than pure ALOHA, because both stations have the decency to desist from interfering with the third station's frame. Intuitively, this will lead to a higher performance than pure ALOHA. Exactly the same holds for slotted ALOHA.

A second carrier sense protocol is non persistent CSMA. In this protocol, a conscious attempt is made to be less greedy than in the previous one. Before sending, a channel is sensed by station. If no one else is doing this, the station being sending itself. However, if the channel is already in use, the station does not continually sense it for the purpose or seizing it immediately upon detecting the end of the previous transmission. Instead, it waits a random period of time and then repeats the algorithm. Intuitively this algorithm should lead to better channel utilization and longer delays than I-persistent CSMA.

A) The Binary Exponential Back off Algorithm

The IEEE 802.3 protocol uses binary exponential back off algorithm, whenever a collision occurs during transmission. According to this algorithm, whenever station collide for the first time, each station waits either 0 or 1 slot times before trying again. The simulation model devised in this project report assumes a slot time equal to 51 µsec. If two stations collide and the same number is taken by them, they will collide again. After the 2nd collision, each station picks a random number and wait that number of slot times. If a third collision occurs (the happening probability is 1/4), then the next time the number of slots to wait is chosen at random from the interval 0 to 2 – 1 [7].

In general, after i collisions a random number between 0 and 2^i-1 is chosen and that number of slots is skipped. The randomization interval is fixed at a highest of 1023 slots as after ten collisions have been reached. The controller reports failure back to the station after 16 collisions.

This algorithm, called binary exponential back off, was chosen to dynamically adapt to the number of stations trying to send. It the randomization interval for all collisions was 1023, the chance of two station colliding for a second time would be negligible but the average wait after a collision would be hundreds of slot times, introducing a significant delay. On the other hand if each station always delayed for either 0 or 1 slots then if 100 stations ever tried to send at once they will collide over and over until 99 of them picked 0 and the remaining station picked one or vice versa. This might take years. By having the randomization interval grow exponentially as more and more consecutive collisions occur the algorithm ensures a low delay when only a few stations collide but also ensures that the collision is resolved in a reasonable interval when many stations collide.
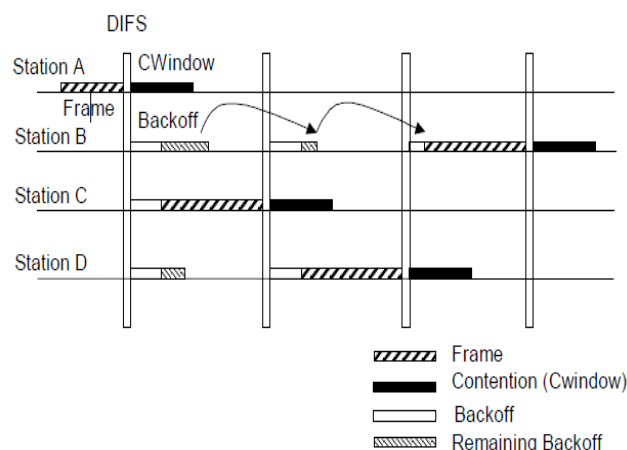

Figure 3.1 Transmissions and Back off Procedure [14]

III. SIMULATION MODEL: IEEE 802.11

The duration used for the simulation runs in this section is 10 seconds. As the accuracy gained as a result beyond 10 seconds

is insignificant. Moreover, for greater than 10 seconds simulation runs under high loads are extremely time consuming, and is beyond the calculation of micro computer. All the coding is done in C language and the programs arc run on both Windows and Linux platforms.

A) Non persistent, p-persistent and IEEE 802.3

An event-driven design is developed for all the models. This implies that rather than being based on pre-determined (fixed) units of time such as "ticks" of a clock, the flow of the time driven program is controlled by event occurred, specifically by the next event, indifferently the type of event may be. Modular code is designed; different modules control different events using an object oriented program of algorithms. The various assumptions and the algorithms are described in the next section.

B) Assumptions

The parameter of simulation group is differentiated in two different groups. The first group contains parameters having constant values. These parameters are discussed and observed in this chapter. The next group contains parameters that are input to the simulation model to observe their effects on performance measures. The second group of parameters is described in section 4.3.

Fixed parameters are defined below.
- Packet lengths are set to 12288 bits.
- The simulations are done for the maximum achievable rate of 10 Mbps. It implies that one packet will take 1.23 ms for transmission.
- The slot-time comprises a contention window which is defined as the fixed unit of time. The value is set at 51 ms. In a slotted multi-access system all events are comprised in terms of slot-times.

Randomly arrival of data packets is assumed that to be served by the medium. The inter arrival times between packet arrivals are independent and exponentially distributed, hence, the packet arrivals are Poisson arrivals. Equation 4.1 is used to generate inter arrival times t, according to an exponential distribution.

$$t = -T * In(r) ....(4.1)$$

T is the mean interracial time, and r is a uniformly distributed random number between 0 and 1.

C) Algorithms

Non persistent CSMA

    While true do

        if channel is free

            transmit the packet;

else if the channel is busy

wait for a random time;

then repeat the algorithm;

1-persistent CSMA

I-persistent CSMA is a special case of p-persistent CSMA, for which the value of p is taken to be equal to 1. [15]

The algorithm changes to

    while true do

        if channel is free

            transmit the packet;

    else if channel is busy

        keep sensing and repeat the algorithm;

    if there is collision

        wait for a random amount of time, and then

repeat the algorithm;

IV. Parameters for the Simulation Models

There are two sets of parameters that are utilized by the simulation models. They are basically divided into two group constant and variable parameter. The former group includes constants that are directly coded into the program. The latter set of group consists of a single parameter, named as load that can be specified for each simulation run. A pilot study is done to define these parameters. For example, three levels of load are considered, high, medium and low. As per pilot studies, network utilization values are sub grouped in high, medium and low load factors of 60, 40 and 20 percent respectively. Tables 4.1 and 4. 2 summarize the parameters.

Table 4.1 Constant Parameters

Slot time	51	μsec
Packet Size	12288	Bits
Maximum channel capacity	10	Mbps
Iterations needed for serving a packet	24	
Simulation duration	10	Seconds

Table 4.2 Variable Parameters

High Load	6 and above	Mbps
Medium Load	4-6	Mbps
Low Load	0-4	Mbps

Since the models for 1-persistent, 0.5- persistent and 1-persistent CSMA/CD are developed on the top of the non persistent CSMA, they use the same sets of constant and variable parameters as described above in their models

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V. Performance results
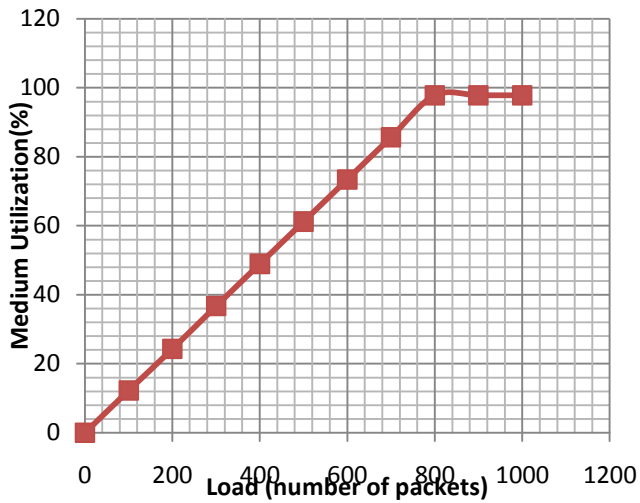
A) Medium Utilization
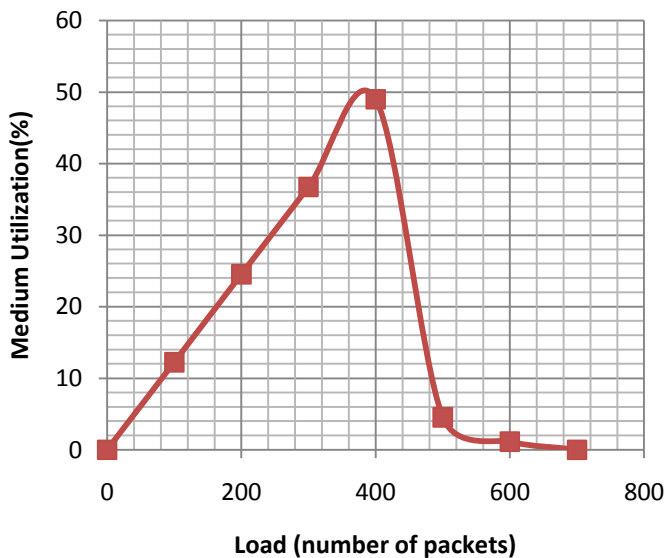

Figure 5.1 Non persistent CSMA

Figure 5.2 1-persistent CSMA

The first graph of non persistent CSMA shows that the medium utilization increases linearly as the load increases. Beyond the maximum channel capacity, the curve becomes almost horizontal. It is because the channel becomes saturated beyond that point.

From the second graph of 1-persistent CSMA, it is clear that the medium utilization linearly increases as the load increases. But this holds true only at low to medium loads. For these values of load the curve is identical to that of no persistent CSMA depicted in Figure 5.1. But as the total load enters the high load region, the performance of the protocol degrades very sharply. This was expected too with the kind of algorithm, 1-persistent CSMA employs.
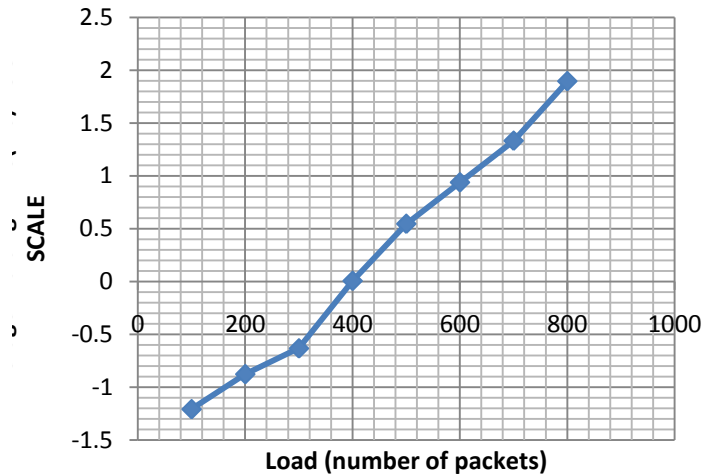
B) Average waiting Time
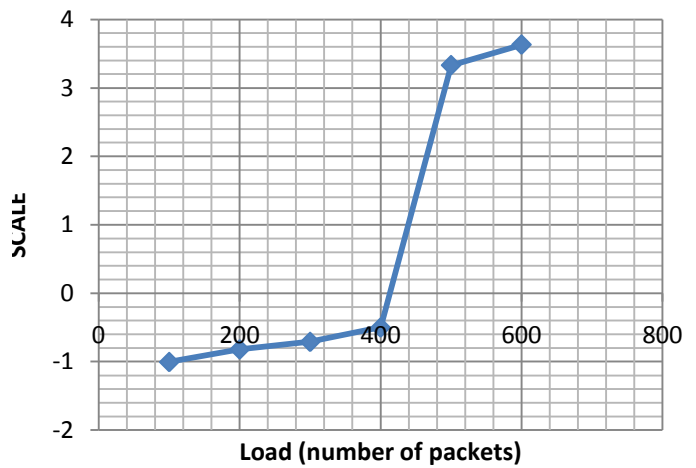

Figure 5.3 Non Persistent CSMA

Figure 5.4 1-Persistent CSMA

From graph of non persistent CSMA (figure 5.3) we observe that the value of the average waiting time is taken on a logarithmic scale to accommodate the large average waiting time variations as the load increases. From figure 4 we observe that the protocol gives significant advantage over non persistent CSMA in the terms of average waiting time per packet when the load is medium. This is because, in this protocol, when any new packet finds the channel busy, it keeps sensing the channel to take hold of it as soon as it becomes free. But the same feature of this protocol results in poor performance at high loads. It happens because the number of collisions increases sharply at higher loads which result in more retransmissions and the packets start taking more time in getting through.

VI. Conclusion

In the previous sections, this research described the various random access techniques employed in the medium access sub layer for both the wired and wireless networks. Various computer simulation models were developed to understand the

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behaviour of no persistent CSMA, 1-persistent CSMA, p-persistent CSMA, CSMA/CD, and CSMA/CA protocols. The performance measures, including medium utilization and average waiting time were evaluated for these carrier sensing protocols.

It is clear from the simulation results that though non persistent CSMA utilizes the medium very efficiently, but the average waiting time is more as compared with 1-persistent CSMA. But this observation is true only till the load on the channel is medium. At high loads, the performance of the 1-persistent CSMA protocol falls very rapidly.

The performance measures of 1-persistent CSMA can be improved greatly by incorporating the collision detection as is done in CSMA/CD. The results obtained by our simulation models also indicate the same phenomenon. At high loads, where 1-persistent CSMA simply failed to deliver, CSMA/CD was able to cope up with the increasing load factor. One more noticeable point is that the maximum medium utilization for 1-persistent CSMA protocol was 48.96%.

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