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Performance of Protocols in Communication

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Abstract—The main objective of this study is to analyze the performance of protocols with the help of coding. This paper presents the analysis of the maximum throughput of pure ALOHA, slotted ALOHA & CSMA protocol and comparison between them. This is carried – out by using MATLAB programming.

***Keywords*—**Pure ALOHA, Slotted ALOHA, CSMA, maximum throughput

I. INTRODUCTION

Protocol is a set of rules or procedures for transmitting data between electronic contrivances, such as computers.

For computers to exchange information, there must be a preexisting agreement as to how the information will be structured and how each side will send and receive it.

II. PURE ALOHA PROTOCOL

The version of the protocol (now called "Pure ALOHA", and the one implemented in ALOHA net) was quite simple:
If you have data to send, send the data.

If, while you are transmitting data, you receive any data from another station, there has been a message collision. All transmitting stations will require to resend "later".

The throughput can be calculated as the rate of transmission-attempts multiplied by the probability of success, and it can be given as throughput (S_{pure}) ,

$S_{pure}=Ge^{-2G}$,Vulnerable time=2*T

Flow Chart for Pure ALOHA

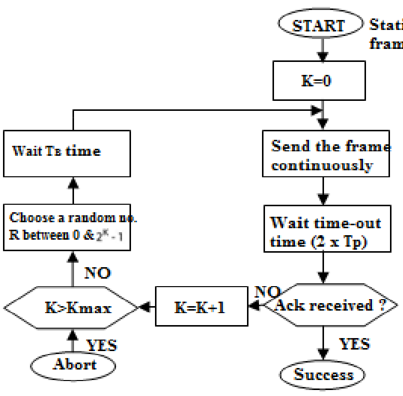

Fig.1

III. SLOTTED ALOHA PROTOCOL

In this case, only transmission-attempts within 1 frame-time and not 2 consecutive frame-times need to be considered, since collisions can only occur during each timeslot. Thus, the probability of there being zero transmission-attempts by other stations in a single timeslot is:

$Prob_{slotted}=e^{-G}$

the probability of a transmission requiring exactly k attempts is (k-1 collisions and 1 success):

$Prob_{slotted}$ k$=e^{-G}(1-e^{-G})^{k-1}$

The throughput is:

$S_{slotted} = Ge^{-G}$

The maximum throughput is 1/e frames per frame-time (reached when G = 1), which is approximately 0.368 frames per frame-time, or 36.8%.

Flow Chart for Slotted ALOHA

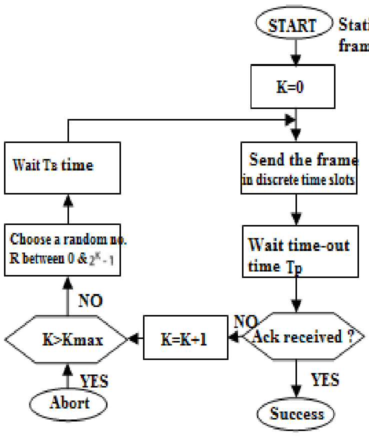

Fig.2

IV. NON- PERSISTENCE CSMA

The non-persistent CSMA: go away when channel is busy. If the node senses that the carrier is busy, it performs a back-off procedure: The node selects a random number X. The node then wait X time units (slots) and repeat the protocol from the start. If the node senses that the carrier is idle, the node transmits in the next slot. After transmitting a message, the CSMA protocol terminates (Message do not need to be acknowledged).

Flow Chart of Non-persistent

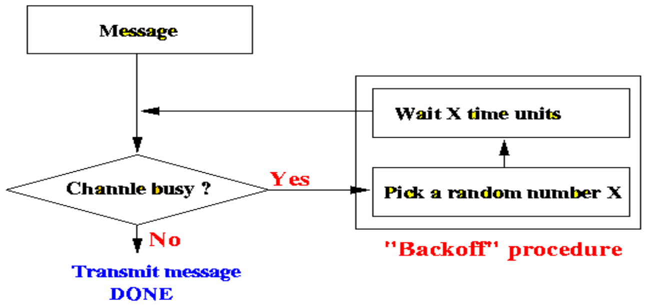

Fig.3

V. 1-PERSISTENCE CSMA

The 1-persistent CSMA protocol: stalk with a purpose. If node senses that the carrier busy, it waits (stalks) until the channel becomes idle. If node senses that the carrier is idle, the node transmits the message in the next slot. After transmitting a message, the CSMA protocol terminates.

Message do not need to be acknowledged. When 2 or more nodes are waiting for the current transmission to end (using 1-persistent CSMA) their transmissions will surely collide the current transmission ends. Performs very well in lightly loaded systems- i.e., when there are few nodes that have messages to transmit.

A node that finds the channel busy that is most likely be the only node waiting for the channel to become clear and it will start transmitting as soon as the current transmission is done and will not waste any time. Performance will suck at heavy amount of load.
There will be an excessive number of collisions.

Flow Chart of 1-persistent

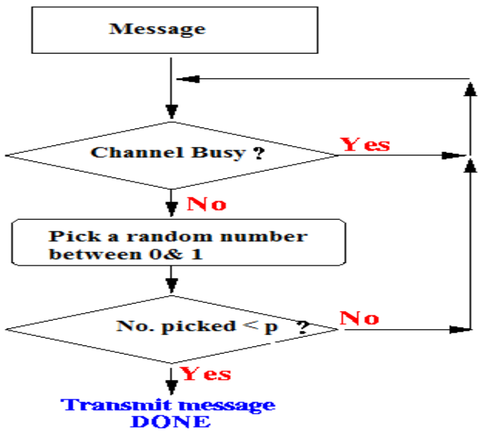

Fig.4

VI. RESPONSES OBTAINED FROM MATLAB CODE

A) PURE ALOHA PROTOCOL

Simulated Performance of Pure ALOHA

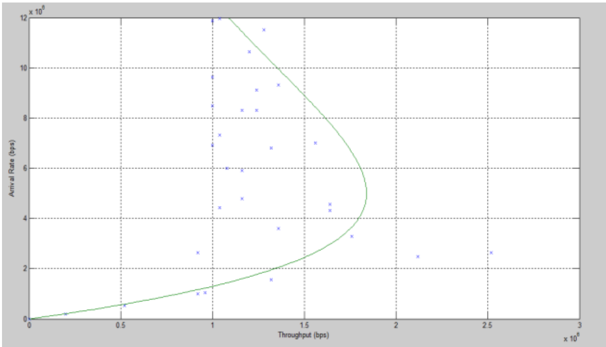

Fig.5

From the obtained graph, we can observe that the efficiency of maximum throughput is *1/e* frames per frame-time which is approximately 0.368 frames per frame-time, or 36.8%.

B) SLOTTED ALOHA PROTOCOL

Simulated Performance of Slotted ALOHA

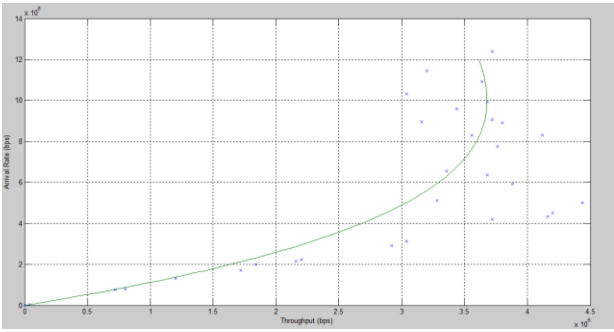

Fig.6

From the above graph, the maximum throughput Smax is 0.184, for G = 1. In other words, if one-half a frame is generated during one frame transmission time (in other words, one frame during two frame transmission times), then 18.4 percent of these frames reach their destination successfully.

C) COMPARISON BETWEEN PURE ALOHA & SLOTTED ALOHA

a) Introduced

The pure ALOHA was introduced by Norman Abramson and his associates at the University of Hawaii in 1970, whereas the Slotted ALOHA was introduced by Roberts in 1972.

b) Frame Transmission

In Pure ALOHA , the user can transmit the data frame whenever the station has the data to be transmitted while in Slotted ALOHA , the utilizer has to wait till the next time slot start, to transmit the data frame.

c) Time
In Pure ALOHA the time is continuous while in slotted aloha the time is discrete.

d) Successful Transmission
In Pure ALOHA, the probability of successful transmission of the data frame is:
$S_{pure} = Ge^{-2G}$
while in slotted ALOHA, The probability of prosperous transmission of the data frame is:

$$S_{slotted} = Ge^{-G}$$

e) Synchronization
In pure ALOHA, the time is not globally synchronized while in Slotted ALOHA , the time here is globally synchronized.
f) Throughput
In Pure ALOHA, the maximum throughput occurs at G = 1/2 which is 18% while in Slotted ALOHA, the maximum throughput occurs at G = 1 which is 37%.

D)NON-PERSISTENCE CSMA PROTOCOL

Simulation of Non-Persistence

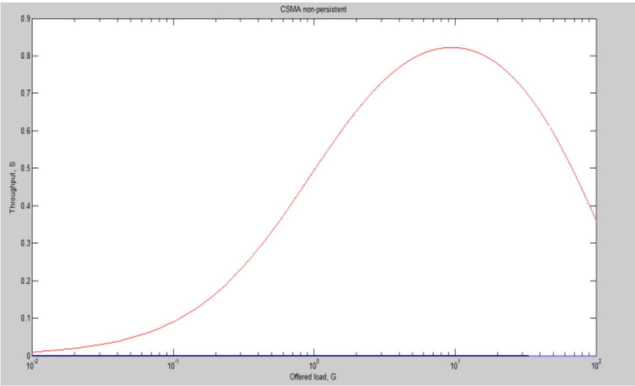

Fig.7

From the s approximately that is obtained above graph, the maximum throughput 81%.

E) 1-PERSISTENCE CSMA PROTOCOL

Simulation Performance of 1-Persistence

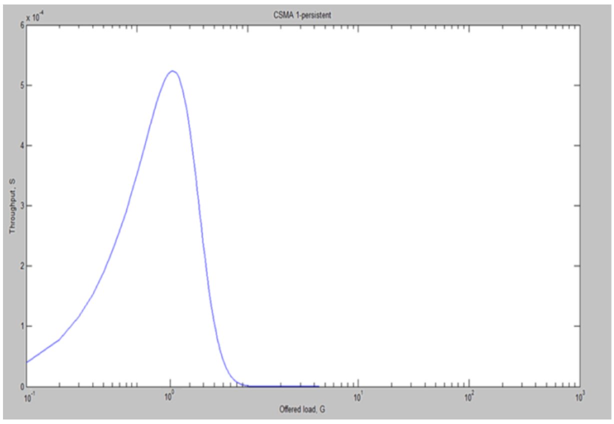

Fig.8

From the above graph, the maximum throughput is 53% .

F) COMPARISON BETWEEN NON-PERSISTENT CSMA & 1- PERSISTENT CSMA PROTOCOL

a)Non-persistent CSMA
It is deferential and less aggressive when compared to its persistent counterpart. It senses the channel and if it is busy it just waits and then again after sometime senses the channel unlike persistent CSMA which keeps on sensing the channel continuously. As and when the channel is found free, the data packet is transmitted immediately. If there occurs a collision it waits and starts again. In this protocol, even if the two stations become greedy in midst of transmission of some other station they do not collide probably whereas, in persistent CSMA they collide. Also, if only one of the stations become greedy in midst of some other transmission in progress, it has no choice but to wait. In persistent CSMA this greedy stations takes over the channel up on completion of the current transmission. Using non – persistent CSMA can reduce the number of collisions whereas persistent CSMA only increases the risk. But the non – persistent CSMA is less efficient when compared to the persistent CSMA. Efficiency lies in the ability of the protocols of detecting the collisions before starting the transmission.

b) 1-Persistent CSMA
In 1-Persistent CSMA it first senses the transmission channel and acts accordingly. If the channel is found to be occupied by some other transmission, it keeps listening or sensing the channel and as soon as the channel becomes free or idle, starts its transmission. On the other hand, if the channel is found empty, then it does not wait and starts transmitting immediately. There are possibilities of collisions. If one occurs, the transmitter must wait for random time duration and start again with the transmission. It has a type called 1 – persistent protocol which makes transmission of probability 1 whenever the channel is idle.

G)APPLICATIONS
- SCADA Systems
- Low-data-rate tactical satellite communications networks by military forces.
- In subscriber-based satellite communications networks.
- Mobile telephony call setup
- Set-top box communications
- In the contactless RFID technologies

VII. RESULTS AND CONCLUSIONS

Pure Aloha gives its performance as 36.8%, Slotted Aloha gives 18.4%, non-persistence CSMA protocol gives its throughput as 81% and 1-persistent CSMA protocol gives 53%. Out of all mentioned protocol types, it is found that Non-persistence CSMA performs the best.

VIII. APPENDIX

Total simulation time,
Runtime= 0.2 seconds
Number of stations = 10
Transmission
throughput=

$$10^6 b/sec$$

Frame size = 8000 bits
Average frame arrival rate per simulation iteration,

$$t_{rh} = \frac{f_{rate}}{10000} = \frac{10}{10000} = 0.001$$

Random Wait Window =100

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Amogha. A. K. has completed her early education at Kendriya Vidyalaya. Later, she has completed her Bachelor of Engineering degree in Electrical and Electronics during the year 2017 under Visvesvaraya Technological University, India, further she continued her post graduation and completed during 2019 in Power Systems Engineering M.Tech under same university. She has presented several technical papers in seminars, conferences and in multiple International Journal publications also.

