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Improvement of Hybrid ALOHA with simultaneous data transmission for 5 users

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ABSTRACT

In this paper, a study for medium access control (MAC) protocol, named hybrid ALOHA with a purpose, to improve the possibility of performance, in simultaneous data transmission for 4 users is measured. Which in the previous work reviewed, the simultaneous data transmission for 2/3 users has been considered only. The basic idea in this paper is, to consider the usage of hybrid aloha protocol to compute performance for 4 users. So, with the hybrid aloha protocol, it is possible to use general multi-packet reception (MPR) as an interface between the MAC layer and physical (PHY) layer, through checking the performance for 5 users. Hence, there is a significant performance improvement in comparison with the traditional ALOHA protocol; even with 2-3 users in hybrid aloha protocol.

Keywords: MAC, ALOHA, MPR, Hybrid ALOHA

INTRODUCTION

In recent years, a vast study on Media Access Control (MAC) has been done, which ALOHA can be considered as one of the dynamic method in multiple access to channel, that was invented by ***Abramson*** in 1970. The main idea of this protocol belongs to any system, which the users in an unarranged way, may compete to use a common available channel. In this method, in fact the initial type of collision is random access. This is the base for any other protocols [1]. In 1972 ***SLOTTED ALOHA*** was suggested by ***Roberts*** for optimization of ***ALOHA*** network. The algorithm of this method is as under, firstly the channel will be divided into time slots, which their width would be as big as the time of a frame. As information becomes ready, station waits till; it reaches to the first of next slot. Then the information packet would be transmitted on channel [2]. There has been much studies on ***SLOTTED ALOHA*** and its optimization [3][4], even on the usage of the ***ALOHA*** protocol in various fields like: ***RFID*** technology, ***Ad-hoc*** networks, M***arine*** networks, and … [5][6][7]. In 2005 ***Dr. Lee*** presented a new protocol by the name ***Hybrid Aloha,*** which could make the simultaneous transmission possible. So, she could improve and optimize the system function to some extent. She could obtain the system throughput up to 2 users [8], although; she could improve it up to 3 users in 2007 [9]. So, our investigation and study is in continuous of her work. Therefore; the introduced system model is similar to her system model to some extent. Before everything, it should be informed that, the discussing system would be based on ***MPR***. Multipacket reception Model (MPR) would play a role as a relation between MAC layer and PHY layer. MPR Model was presented by ***GHEZ*** (et.al.), which in it; the packet admission is indicated with probable condition instead of certain failure or success [10]. Besides, ***Naware*** offered Asymmetric MPR [11]. Now, although we are planning to take into consideration the throughput rate for the same system, but it is for 5 users. First of all, the system model would be surveyed, then Hybrid Aloha protocol would be commenced, and in the next part we review the transmission throughput rate for 5 users. Then, there would be a functional comparison between them, and at last there would be a conclusion.

MATERIALS AND METHODS

System Model:
In system Model, a wireless network for 5 users which communicates with a common base (access point) is taken into consideration.
It's to be notified that, MPR Model is used for this system.

- ✓ The channel is slotted in time
- ✓ Each user is equipped an infinite buffer
- ✓ Packets are in the same size
- ✓ Packets contain two parts ***training sequence*** and, ***information data*** which are capable of being sent individually in a length of a slot.
- ✓ each user can enter separately
- ✓ The length of the training sequence is typically much smaller than that of the information data
- ✓ For each system with N users M={1,2,3,…,N} for any subset R⊆ M, of users transmitting in a slot, the *marginal* probability of successfully receiving packets from users in $R \subseteq S$, given that users in transmit, is defined as:

$$q_{R|S} = \sum_{U:R\subset U\subset S} q_{U,S}$$

Hybrid Aloha:
The proposed hybrid ALOHA protocol aims at improving MPR capability by allowing conditional collision-free channel estimation and simultaneous transmission was presented by ***Dr. Lee*** [7]. In hybrid ALOHA, if the aim of simultaneous transmission is for M users and for each ***SLOTE***, so we consider M+1 subset. Therefore; each ***SLOTE*** contains data subslot and many Pilot subslote, which always the information regarding data, would be in the third subslote (data subslote) and each user can randomly select a pilot subslot to transmit his training sequence. It should be notified that, in this protocol the length of ***pilot subslote*** is equal to τ, which is much smaller than ***data subslote*** as 1- τ. It is obvious that, collision just occur when we have more than M users simultaneously. In this survey we have considered the length of time unit by 1 and length of τ by 0.05. Thus, there are 6 subslote for 5 users as we have 5 pilot subslote.

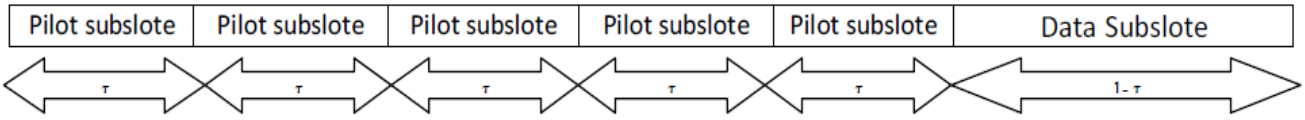
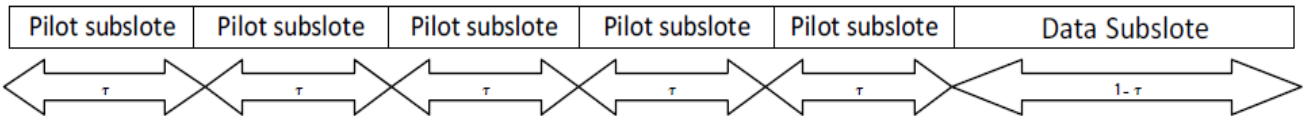


Figure 1: Hybrid ALOHA for 5 users

Throughput:
The throughput is determined by finding the average traffic successfully getting through the channel, $V(\tau)=E[T_t]$ and T_t denotes the number of packets successfully getting through the channel during slot. Let Λ be the overall arrival rate to the system, in the unit of *number of packets per unit time*. i.e., $\Lambda = \sum_{i=1}^{N} \Lambda_i$. Where Λ_i is the arrival rate of the i^{th} user measured in *packets per unit time*. The average traffic per slot is $R(\tau) = \Lambda(M\tau + 1 - \tau)$, denote A_K as the event that K users transmit in one slot and denote A^i_k as the event that exactly out of K users succeed in transmission, then $P_r\{A^i_K|A_K\}$ is determined by the MPR capability of the system [7].

Under the symmetric MPR model, as well as the Poisson approximation with parameter $R(\tau)=(M\ \tau\ 1-\ \tau)$, the throughput of hybrid ALOHA, measured in *packets per hybrid ALOHA slot*, is given by:



$$\nu(\tau) = R(\tau) \sum_{K=1}^{M} \sum_{i=1}^{K} \frac{i}{K} \Pr\left\{A_K^i | A_K\right\} \frac{R(\tau)^{K-1} e^{-R(\tau)}}{(K-1)!}$$

RESULTS AND DISCUSSION

Throughput for 5 users:

In Dr. Lee papers throughput is considered for 2-3 users, here we have continued the same way to obtain throughput for 5 users. In the below computation we are getting throughput for 5 users, $\therefore M = 5$.

We have processed as:

$P_r\{A_1^1 \mid A_1\} = 1$

$P_r\{A_2^2 \mid A_2\} = \frac{4}{5}$

$P_r\{A_3^1 \mid A_3\} = \frac{12}{25}$

$P_r\{A_3^3 \mid A_3\} = \frac{12}{25}$

$P_r\{A_4^1 \mid A_4\} = \frac{16}{125}$

$P_r\{A_4^2 \mid A_4\} = \frac{72}{125}$

$P_r\{A_4^4 \mid A_4\} = \frac{24}{125}$

$P_r\{A_5^1 \mid A_5\} = \frac{8}{25}$

$P_r\{A_5^2 \mid A_5\} = \frac{24}{125}$

$P_r\{A_5^3 \mid A_5\} = \frac{48}{125}$

$P_r\{A_5^5 \mid A_5\} = \frac{24}{625}$

According to the above equations, throughput for 5 users, would be as follows:

$$V(\tau) = R(\tau)\, e^{-R(\tau)} \left(1 + \frac{4}{5} R(\tau) + \frac{8}{25} R(\tau)^2 + \frac{32}{375} R(\tau)^3 + \frac{32}{1875} R(\tau)^4\right)$$

To normalize system throughput for 5 users in the ratio of time length, we have:

$$\frac{V(\tau)}{1.2}$$

The system throughput diagram for 5 users by MATLAB software, with different rate of R and number of various users, is shown below.

Table 1: Throughput comparison in Hybrid ALOHA for different No. of users with different rate of R

R → No. of ↓ Users	0	1	2	3	4	5	6	7
2 Users	0	0.5255	0.5159	0.3556	0.2093	0.1123	0.0567	0.02877
3 Users	0	0.6317	0.7929	0.6789	0.4810	0.3029	0.1758	0.0961
4 Users	0	0.6723	0.9856	0.9974	0.8282	0.6026	0.3985	0.2450
5 Users	0	0.6813	1.0907	1.2405	1.1692	0.9635	0.7172	0.4922

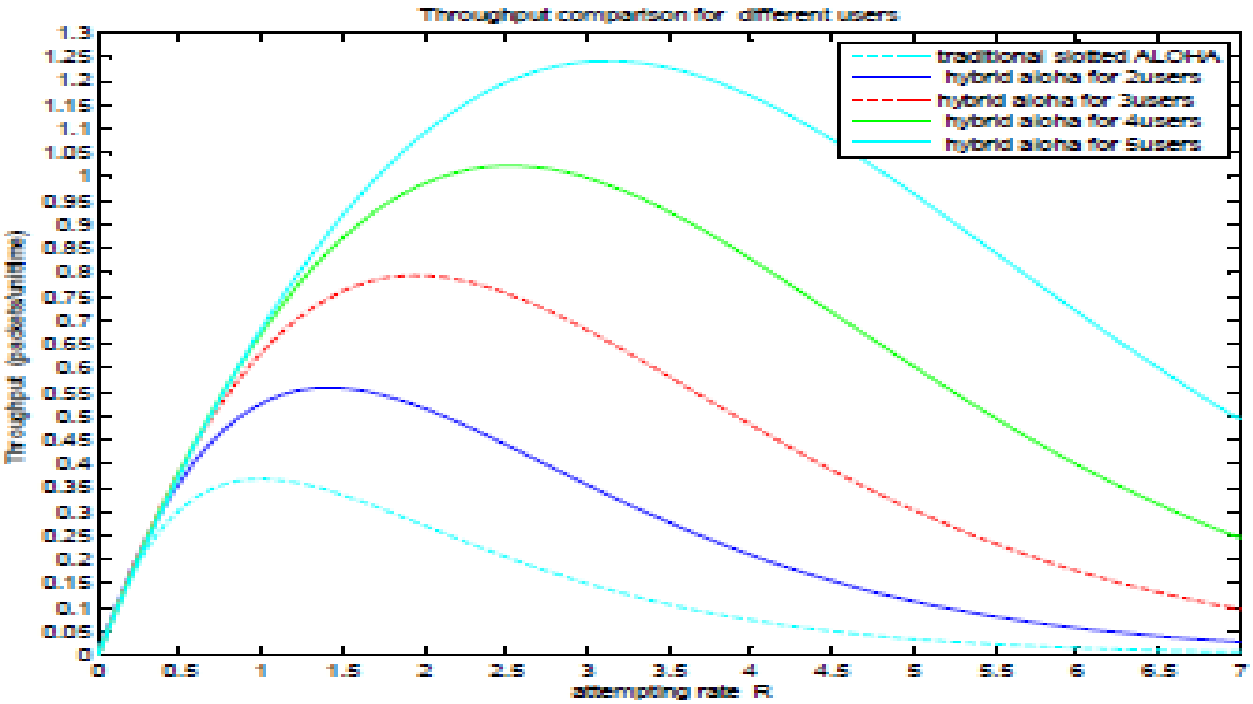


Diagram 1: Throughput comparison for different number of users

Since it's implicated, Hybrid ALOHA method for 5 users in compare to the old ALOHA model towards 2, 3 and 4 users, has got some optimization order wise as: 231%, 121%, 56% and 21%

CONCLUSION

In this paper, a survey for Media Access Control protocol ***Hybrid ALOHA*** with the goal of system performance improvement, and monitoring throughput for simultaneous transmission of 5 user's have been done. In the previous works, possibility of simultaneous transmission, only for 2 or 3 users were studied. But, in our last previous work we obtained the same for 4 users. Using ***Hybrid ALOHA*** model, there is a possibility of using Multiple Packet receiving (MPR) as an interface between the MAC layer and PHY layer. With evaluation of system performance for 5 users in ***Hybrid ALOHA*** protocol, we could significantly observe an improvement compared to the traditional Aloha for 2, 3 and 4 users.

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