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Study of subscriber satisfaction in slotted aloha and resource allocation algorithm of GSM network

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ABSTRACT

Determination of subscriber satisfaction level during the period of getting access towards wireless network would support service providers to optimize their network. The subscriber satisfaction level with respect to successful call attempt was studied considering Slotted Aloha and Fixed Resource allocation (FCA) algorithm of GSM Network. The uniform allocation of aloha channel among all the subscribers was found when simulation was carried out for one hour. Slotted Aloha Algorithm performance found to be excellent when it was analyzed for a longer duration. In FCA, the percentage of total subscribers accessing the network in busy hour found to be very less and would result in high level of subscriber dissatisfaction. A novel method of resource allocation technique is proposed to improve the subscriber satisfaction while accessing the network in busy hour. An average improvement of 35 % was found in proposed method.

Introduction

One of the key challenges in optimization of mobile network is to provide uniform subscriber satisfaction during accessing the network when network is busy. The slotted aloha algorithm is the currently used method of accessing the mobile network and would not consider any factors of congestion in the network. Therefore any customer who had accessed the network most recently during busy hour would have equal chance of getting access to the network. There are chances of a particular subscriber getting access to the network more number of times while others may fail to get access even after repeated attempt. The phenomenon would result in high level of user dissatisfaction and demand an alternative approach to tackle such situation. After successful access to the slotted aloha channel, the mobile subscriber will be allotted with signaling channel and traffic channel (TCH) based on the resource availability. The objective of this paper is to study the slotted Aloha and resource allocation algorithms of GSM mobile network and to determine satisfaction level of the user while accessing the network during busy hour. The resource allocation algorithms such as fixed channel allocation and dynamic channel allocation are studied.

Aloha protocols

ALOHA was developed in the 1970s for a packet radio network at the University of Hawaii. In the 1990s, Matti Makkonen and others at Telecom Finland greatly expanded the use of ALOHA channels in order to implement SMS message texting in 2G mobile phones. [1 2].

Pure aloha

The first multi access protocol is known as pure Aloha and is a fully decentralized medium access control protocol that does not perform carrier sensing.

The principle of Pure Aloha is to transmit the data whenever data is available to transmit and if transmitted message collides with another transmission re transmit the message after random wait period. Fig 1 shows the principle of Pure Aloha Protocol. Boxes indicate the frames and shaded boxes indicate frames which have collided. The Pure ALOHA does not check whether the channel is busy before transmitting and the quality of the backoff scheme chosen significantly influences the efficiency of the protocol, channel capacity and the predictability of its behavior.

The theoretically proven maximum utilization of time for successful transmissions with this protocol (assuming Poisson arrival) is 18.4 % [3].

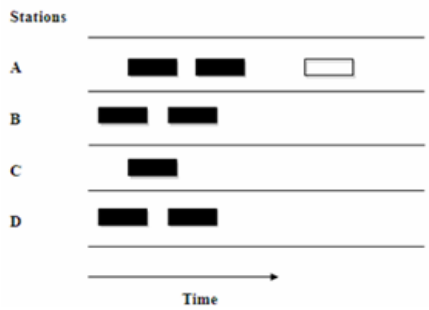

Figure 1 Pure ALOHA protocol

Slotted aloha

The slotted-Aloha protocol [4] was introduced to improve the utilization of the shared medium by synchronizing the transmission of devices within time-slots. Today, various forms of slotted-Aloha protocols are widely used in most of the current digital cellular networks, such as the Global System for Mobile communications (GSM).

The Slotted ALOHA protocol was an improvement where time is divided into discrete time intervals (slots) and a packet can only be transmitted at the beginning of a slot.

Here packets either collide completely or do not collide at all and thus total collisions are reduced.

This protocol doubles the channel utilization of pure ALOHA to 36.8 %[5].

Fig. 2 shows the principle of Slotted Aloha protocol. Boxes indicate Frames. Shaded boxes indicate frames which are in the same slots.

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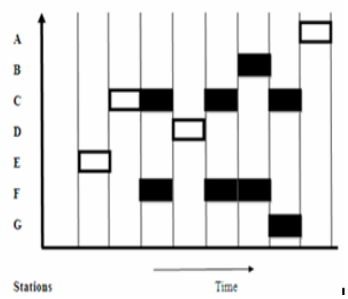

Figure 2.Slotted ALOHA protocol

Radio Resource Allocation Algorithm

Channel allocation strategies determine how the available or future available channels will be distributed among candidate or connected mobile users. Based on the service types (eg. Voice , data , video) a mobile user request can be served by different number of channels and quality level. In many cases the traffic conditions cannot be predicted which results in large number of constraints for effective usage of exisitng channel allocation schemes. The channel allocation schemes in general belong to three categories viz. Fixed Channel Allocation (FCA), Dynamic Channel Allocation (DCA) and Hybrid Channel Allocation (HCA). In FCA, fixed number of channels is allocated to the available Base stations (BSs) of the wireless network. In this case, traffic pre-estimation must be made in order to compute the number of channels for each BS[6]. A set with variable and constant channels is allocated ot each BS in the case of DCA approach[7]. Finally the advantages of FCA and DCA strategies are combined to constitue the HCA appraoch[8]. None of the resource allocation algorithms found in the literature consider the factor of uniform allocation of available channels among mutiple requests which could result in non uniform distribution of channels and poor subscriber satisfaction. There are chances of a particular subscriber getting traffic channel more number of times while others may fail to get access even after repeated attempt during busy hour. A novel resouce allocation algorithm is proposed which allocates the channel based on priority and past channel holding time during busy hour.

Fixed channel allocation algorithm

The flow chart of fixed channel allocation algorithm is shown in fig.3. Every cell is assigned a fixed pool of frequencies, so that no near cells can use the same channel. The traffic channels (TCHs) are allocated to the subscribers based on channel request and availability of channels [9]. The TCH success count is incremented for every successful TCH allocation. When all channels are in use, subsequent requests shall be rejected and counted as TCH failures [10].

Novel resource allocation algorithm

The flow chart of novel resource allocation algorithm is shown in fig.4. Every cell is assigned a fixed pool of frequencies, so that no near cells can use the same channel. The traffic channels (TCHs) are allocated to the subscribers based on channel request, availability of channels and priority value assigned to the subscriber. The priority variable is a function of total success and channel hold time which is updated after every successful allocation.

The Server priority variable is an intermediate variable which dynamically gets updated whenever priority variable is greater than or equal to server priority. The use of priority and server priority variable avoid continuous repeated allocation of channel for the same subscriber during busy hour and help in distribution of channels among multiple subscribers within the cells.

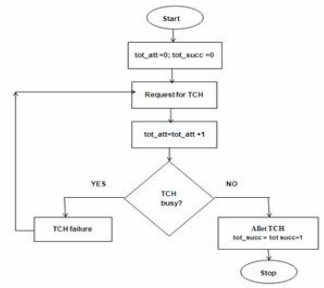

Figure 3. Flow chart of fixed channel Allocation Algorithm

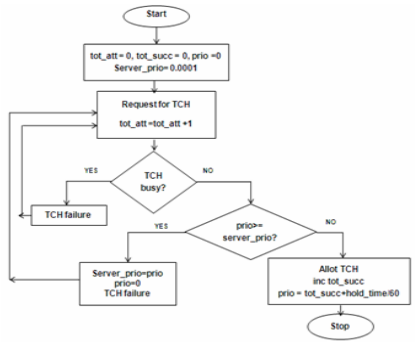

Figure 4. Novel Resource Allocation Algorithm

Simulation Results

Slotted Aloha algorithm was simulated for a GSM Network with an assumption of twenty subscribers trying to access the slotted aloha channel randomly. The simulation was carried out for different time duration and the results are depicted in the Fig. 5, Fig. 6 and Fig. 7. It was observed that success rate of allocation of random access channel was not uniformly distributed during short simulation time of one and five minutes. All the subscribers were successful in getting slotted aloha channel when the simulation was extended for one hour as shown in Fig.7. The successful allocation of slotted aloha channel among multiple subscribers would improve the satisfaction level among subscribers while trying for initial access with the network.

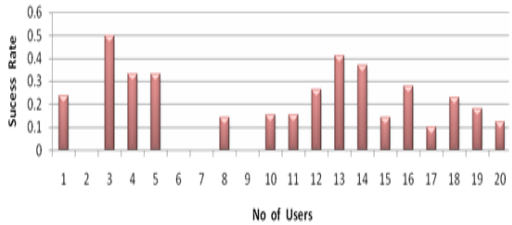

Figure 5. Results of Slotted Aloha Simulation with simulation time = 1 min

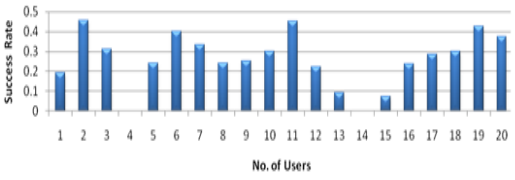

Figure 6. Results of Slotted Aloha Simulation with simulation time = 5 min

The fixed channel allocation algorithm was simulated for busy hour with an assumption of twenty subscribers trying to access the network. The call arrival rate was assumed to be random with maximum call holding time of 10 minutes. The result of simulation is shown in fig. 8 and found that 25 % of total subscribers were able to access the network in busy hour. The remaining 75 % of total subscribers are unsatisfied because of non availability of the radio channels. The simulation result

of novel radio resource allocation algorithm is shown in fig. 9 with the same set of twenty subscribers trying to access the network in busy hour and with same network assumptions. It was found that 60% of total subscribers were able to access the network in busy hour with an average improvement of 35 % when compared to fixed channel allocation algorithm.

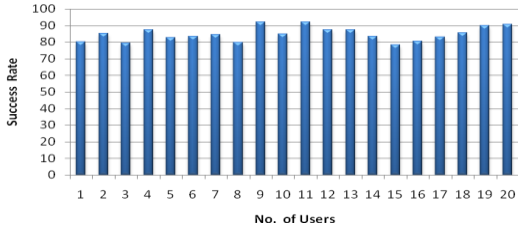

Figure 7 Results of Slotted Aloha Simulation with Simulation time = 1 Hr

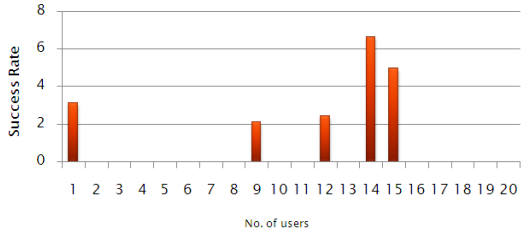

Figure 8 Simulation Results of Fixed Channel Allocation algorithm with Simulation time = 1Hr

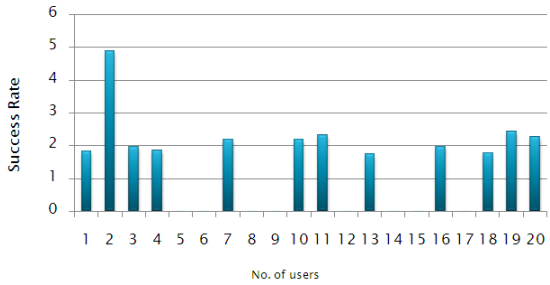

Figure 9 Simulation Results of Novel Resource Allocation algorithm with Simulation time = 1Hr

Conclusion

Simulation results of slotted aloha algorithm shows that there are possibilities of non uniform distribution of success rate among subscribers trying to access a network during any small instant of time in busy hour. During this short time user will be highly dissatisfied and may not show interest to retry for getting access of the network and could result in loss of revenue. However the overall performance of Slotted Aloha found to be satisfactory when the simulation was carried out for entire busy hour. This shows that every subscriber who is trying to access a network using slotted aloha algorithm would be uniformly satisfied if they wait and retry during the entire period of busy hour. The performance of fixed channel allocation was studied in comparison with proposed resource allocation algorithm and found that 60% of total subscribers were able to access the network in proposed algorithm when compared to 25 % in case of fixed channel allocation. The improved success rate would help in improving satisfaction level of subscribers during busy hour.

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