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Improvement The Transmission Efficiency For Wireless Packet Communication Systems Using Automatic Control for power And Time Slot Width Of Slotted Non persistent ISMA Protocol

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Abstract

In packed communication systems which use a protocol, the protocol should perform the allocation of channels such that the transmission channel is used efficiently. Efficiency is usually measured in terms of *channel throughput* and the average transmission delay. The Slotted Nonpersistent ISMA protocol is one of random access protocols used in packed communication systems. In this research a Slotted Nonpersistent ISMA protocol Model with automatic control for power and time slot is proposed. the suggested algorithm enable the base station(access point) to control the protocol time slot length and transmission power in a dynamic way to control the normalized propagation delay *d* and to maintain all the uplink signals in the limit of captured power threshold (capture ratio) in order to control the throughput and the average transmission delay of the communication system by an automatic method. the computer simulation results confirm the activity of the proposed algorithm for increasing the throughput and decreasing the average transmission delay by an accepted ratios.

Keywords: ISMA protocol, CDMA, Throughput (S), Average Transmission Delay (D), Packet Communication Systems.

تحسين كفاءة الإرسال لأنظمة اتصالات الحزمة باستخدام السيطرة الأوتوماتيكية للقدرة وعرض الشقوق الزمنية لبروتوكول الوصول المتعدد بإشارة الخمول الغير مستمر والمجزأ إلى شقوق

الخلاصة

في أنظمة اتصالات الحزمة التي تعتمد بروتوكول في عملية تعدد الدخول ،فأن هذا البروتوكول يجب أن ينفذ عملية تخصيص القنوات بحيث يمكن استغلال قناة النقل بشكل كفوء. حيث تقاس الكفاءة هنا بعاملين هما الطاقة الإنتاجية و معدل تأخير الإرسال. إن بروتوكول الوصول المتعدد بإشارة الخمول الغير مستمر والمجزأ إلى شقوق هو احد بروتوكولات الدخول العشوائي المستخدمة في أنظمة الاتصالات التي تعتمد الحزمة(packet) في إرسالها. في هذا البحث تم اقتراح خوارزمية تمكن نقطة الدخول التي تعتمد هذا البروتوكول من السيطرة الأوتوماتيكية على عرض الشقوق للتحكم بعامل تأخير الانتشار المطبع بصورة ديناميكية وكذلك السيطرة الأوتوماتيكية على قدرة الإرسال الصاعد ضمن عتبة القدرة المنتزعة وذلك للسيطرة الاوتوماتيكية على الطاقة الإنتاجية ومعدل تأخير إرسال لمنظومة الاتصالات. أثبتت نتائج المحاكاة بالحاسوب فعالية الخوارزمية المقترحة في زيادة الطاقة الإنتاجية وتقليل معدل تأخير الإرسال بنسب جيدة .

الكلمات الدالة: بروتوكول الوصول المتعدد بإشارة الخمول، تعدد الوصول بتقسيم الشفرة، الطاقة الإنتاجية، متوسط تأخير الإرسال ، أنظمة اتصالات الحزمة.

List of Abbreviations and Symbols

ALOHA : A type of random access

protocols(name originated at the Hawaii University)

CDMA : Code division multiple Access.

CSMA : Carrier Sense Multiple Access.

CSMA-CD : Carrier Sense Multiple Access with Collision Detection.

ISMA : idle signal multiple Access.

UHF : Ultra high frequency

B : expectation time length of busy period.

D : average transmission delay *(time slots).*

d : normalized propagation Delay.

P_r : probability

P_{succ} **:** the probability of successful transmission period.

G **:** offered traffic (*packet)*

I **:** expectation time length of idle period *(normalized)*

S **:** throughput*(normalized)*

T_p **:** packet time length*(second)*

T_B **:** time of busy slot*(second)*

T_s **:** length of time slot*(second)*

Ti **:** idle slot time *(second)*

T_d **:** propagation delay time *(second).*

$T_{d(max)}$ **:** maximum propagation delay time *(second).*

U **:** expected time length in which no collision occurs *(normalized).*

Introduction

Agreement among users on the means of communication is known as a protocol. When users employ a common medium for communications, it is called multiple access. Thus, the multiple access protocol is defined as the agreement and set of rules among users for the successful transmission of information using a common medium[1]. Whenever a resource is used and accessed by more than one independent user, the need for a multiple access protocol arises. In the absence of such a protocol, conflicts occur if more than one user tries to access the resource at the same time. Therefore, the multiple access protocol should avoid or at least resolve these conflicts[2]. In wireless mobile environment, the protocol should be deals with: (1): collisions among packets sent by users [if more than one user tries to access the channel at the same time]. (2) :The hidden terminal problem[two terminals are out of range(hidden from) each other by hill, a building, or some other physical obstacle opaque to ultra high frequency(UHF) signals but both within the range of the central or base station][3]. generally for all transmission environment , the protocol should perform the allocation of channel capacity to the users such that the transmission channel is used efficiently. Efficiency is usually measured in terms of channel *throughput* and *average transmission delay*[2 , 4] .

Starting in 1970 with the ALOHA protocol, a number of multiple access protocols has been developed. Numerous ways have been suggested to divide these protocols into groups. The multiple access protocols can be divided into three main groups[Figure(1)]:the contention less protocols, the contention protocols, and the class of CDMA protocols[1]. The connectionless (or scheduling) protocols avoid the situation in which two or more users access the channel at the same time by scheduling the transmission of the users. This is either done in a fixed fashion where each user is allocated part of the transmission capacity, or in a demand-assigned fashion where the scheduling only takes place between the users that have something to transmit. With the contention (or random access) protocols, a user cannot be sure that a transmission will not collide because other users may be transmitting (accessing the channel) at the same time. Therefore, these protocols need to resolve conflicts if they occur. The CDMA protocols do not belong to either the contention less or the contention protocols but falls between the two groups. In principle, it is a connectionless protocol where a number of users are allowed to transmit simultaneously without conflict. However, if the number of simultaneously transmitting users rises above a threshold, contention occurs. The contention multiple access protocols are further subdivided into two groups, the repeated random access protocols and random access protocols with reservation. The best-known protocol method for random access packet communication, ALOHA(method devis-ed In the 1970s by Norman **A**bramson and his colleagues at the University of Hawaii) suffers heavily due to collisions among packets[5]. Abramson work has been extended by many researchers since then. Protocols in which stations listen for a carrier (i.e., a transmission) and act accordingly are called carrier sense multiple access protocols CSMA. The CSMA protocol offers higher capacity so it is used today as WLAN protocol(the family of IEEE 802.11 standards used in Wireless local area networks (WLANs) are built With a new version of CSMA protocol called CSMA –CD [6] . Although the CSMA protocol offers higher capacity but its performance is affected by the problem of ‘‘ hidden terminals’’[5]. The third category (ISMA) protocol in which the central base station controls the flow of packets from the mobile terminals, reduces these two problems of collisions among data packets and hidden terminals[7]. Harda and Parsad(1997) have analyzed non-persistent ISMA scheme in detail. They proved that the ISMA is best protocol to solve the Hidden terminal problems[2]. Yang Yang and Tak-Shing(2003) derived the closed-form delay distributions of slotted ALOHA and nonpersistent carrier sense multiple access (CSMA) protocols under steady state[8]. Y. C. Tay, Kyle Jamieson, and Hari Balakrishnan(2004) proposed a nonpersistent carrier sense multiple access (CSMA) protocol named it CSMA/P^*. they show that CSMA/P^* is optimal in the sense that is the unique probability distribution that minimizes collisions between contending stations[9]. Yumei Zhang , Xin Zhang(2008) proposed a multichannel random access based on non-persistent CSMA scheme, They confirm that their proposed algorithm can gives a high network throughput and delay performance but can't solve the hidden terminals problem[10] .

Theoretical analysis of Throughput for The Non-persistent slotted ISMA protocol

In the Nonpersitent ISMA protocol, which is shown in Figure(2), the uplink is slotted by period of one packet T_p plus the length of propagation delay time . when each access terminal generates its packet, the access terminal performs inhibit sense. If it receives an idle signal, the access terminal transmit a packet at the next time slot. On the other hand, if it is receives a busy signal, the access terminal does not transmit and waits until the next time slot, which is decided randomly and then starts the inhibit sense. Here, in the access point, the time slot when the access point transmits a busy signal to all the access terminals is called a busy slot. Moreover, the time slot when the access point transmits an idle signal to all access terminal is called an idle slot. The access point informs all access terminal of the

next timing to transmit packets when it has finished receiving packets for all users. However, if the access point does not receives any packets, the access point also informs the terminals of the next timing.
By taking , the busy slot time T_B equals to a time of one packet T_p plus the length of propagation delay time T_d ,thus[3]:

$$T_B = T_p + T_d \qquad \text{……………………….(1)}$$

and the idle slot time length T_i equals to propagation delay time T_d :

$$T_i = T_d \qquad \text{…………………..……….(2)}$$

Normalizing T_B and T_i by length of One Packet Time slot T_p makes :

$$T_B \text{ (normalized)} = 1 + d \qquad \text{..…..…………….(3)}$$

$$T_i \text{ (normalized)} = d \qquad \text{..…………………..(4)}$$

where d is the normalized propagation delay (propagation delay time T_d divided by time slot length T_s)which is:

$$d = \frac{T_d}{T_p} \qquad \text{……………………..…….(5)}$$

Referring to equation(3) and equation(4) and considering the Poisson scheduling process, we have:

$$B = \frac{1+d}{e^{-dG}} \qquad \text{……………………………(6)}$$

$$I = \frac{d}{1-e^{-dG}} \qquad \text{…………………………(7)}$$

Where B is the expectation time length of a busy period which is follows the exponential distribution.
And I is the expectation time length of an idle period which is also follows the exponential distribution.
The expected time length in which no collision occurs is U and found as:

$$U = \frac{B}{1+d} P_{succ} \qquad \text{…………..…………(8)}$$

Where P_{succ} is the probability of successful transmission period:

$$P_{succ} = \frac{\Pr[single \quad arrival \quad within \quad a \quad slot]}{\Pr[more \quad rrivals \quad within \quad a \quad slot]} \qquad \text{……………………………………(9)}$$

Putting all these together, we get the throughput:

$$S = \frac{U}{B+I} = \frac{dGe^{-dG}}{1+d-e^{-dG}} \qquad \text{……………10)}$$

the theoretical calculation for throughput S means that the throughput is an exponential function of G and d .

The Proposed Slotted Nonpersistent ISMA Protocol With Automatic Control For Power And time Slot Width Model

In the proposed system, the up link is slotted by a time slot called Ts . the value of Ts and the power of up link signals can be controlled dynamically where the access point can calculate the maximum propagation delay time $T_{d(max)}$ according to the distance between the access point and a distant user(the distance from the cell center and any point on cell edge) and then decides the value of Ts according to the required value of normalized propagation delay and the value of propagation delay time $T_{d(max)}$ where ($d = T_{d(max)} / T_s$). after that the access point inform all access terminals (users in it's coverage area) to increase their time packets T_p to a value equal to the new value of Ts . This algorithm is done to control the value of normalized propagation delay d .in other word, to control the Busy slot time ($T_B = Ts + T_{d(max)}$) and the Idle slot time($T_i = T_{d(max)}$) at the required values according to the distance between the access point and a distant user. The controlled value of *d* will increase the throughput *S* and decrease the average transmission delay *D* of the system for the same value of Offered traffic *G* (where *S* and *D* are exponential functions of *d*).

The power of signals sent by a distant users are less than that of closer users , therefore even if a collision does not occur, a packet transmission error occur because the received power at the access point is smaller than the required power . this problem can be solved by making the access terminal control it's transmission power to the required value of captured power threshold according to distance separate it form the access point. The power control technique add more improvement to the throughput and average transmission delay .

Computer Simulation and results

Matlab language code is used to simulate the performance of a packet communication system working with *The Slotted Nonpersistent ISMA protocol with automatic control for power and time slot* Model and to calculate the throughput S and transmission delay of this system. The Basic configuration (flowchart) of the of computer simulation is as shown in Figure(3). In this simulation, we consider the following assumptions:

- A 100 mobile terminals communicating with centrally located base station using packet radio.
- Service area radius = 1000m) .
- Standard deviation of shadowing = 6 dB.
- Attenuation constant α = 3 .
- Bit rate = 11 Mbps.

Each access terminal generates its packets randomly and independently and transmits it according to Poisson distribution where the transmission is controlled by the ISMA protocol with controlled power and time slot period Ts. The throughput is determined practically and theoretically. the practical calculation of throughput *S* is done in the computer simulation by calculating the average number of packets successfully transmitted in a given time interval of the computer simulation divided by the number of attempted transmissions in that interval while the theoretical calculation of S is done by using equation (10) which is derived in theoretical calculation.

The average transmission delay(*D*) is calculated practically by the summation of all packet transmission delay in every active user terminal through simulation.

The simulation result Figure(4) shows that the available maximum value of throughput against Offered traffic (4 packet) is 0 .63 when the time slot T_s is controlled to give a normalized propagation delay *d* equals to 0.1. For the same value of d = 0.1, the practical value of throughput S is improved (increased to 0.67 against offered traffic *G* = 5 packet) when the capturing ratio is increased by increasing the power of the packet sent through the uplink signal.

Figure(5) shows the available improvement (reduction) in average transmission delay *D* using the proposed power control technique only(increasing the capture effect with out changing time slot length i.e *d* remain equal to 0.1).

Figure (6) and Figure(7) show the throughput and average transmission delay against offered traffic respectively When the access point time slot and the :cess terminals powers are controlled .e the normalized propagation delay *d* is reduced from (0.1 with out capturing effect) to (0.01 with capturing effect)]. From figure(6) it is clear that the maximum value of throughput is improved from 0.63 against offered traffic (4 packets) to 0.9 against offered traffic of (25 packets) by decreasing the normalized propagation delay ratio *d* to

0.01 with controlling uplink signals power at the same time . figure(7) shows the improvement in the average transmission delay *D* (*D* is reduced from 500 slot to 100 slot for the same offered traffic *G* = 25 packet) using the proposed algorithm .

Conclusions

From the simulation results we can conclude that the proposed algorithm can give a high throughput (more than 90% against offered traffic *G* = 25 packet) and low average transmission delay *D* (*D* is reduced from 500 slot to 100 slot for the same offered traffic *G* = 25 packet) by controlling the length of time slot T_s(to give normalized propagation delay *d* = 0.01) with controlling the uplink signals power at the same time. This the improvements in Throughput and the average transmission delay means a high and efficient performance with a minimum packets collision of the system. In particular, for short periods of overlap between colliding packets, error correction coding can be suggested as future work to allow one or more packets to be successfully received even with a collision **.**

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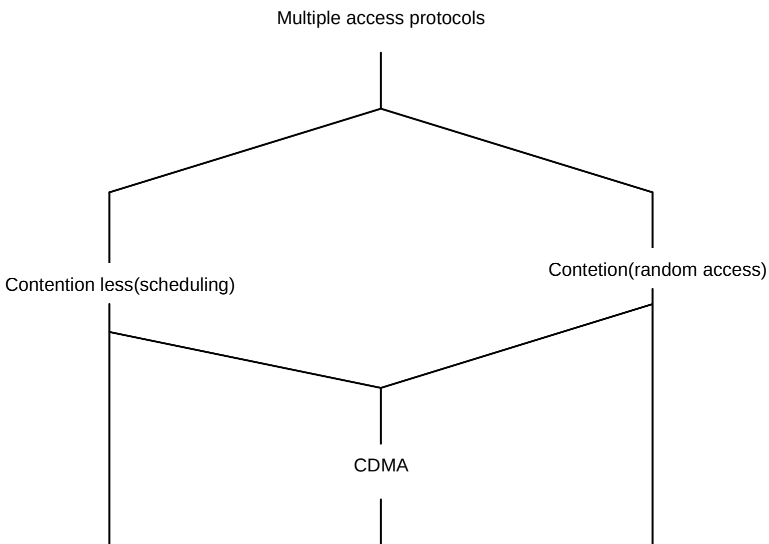

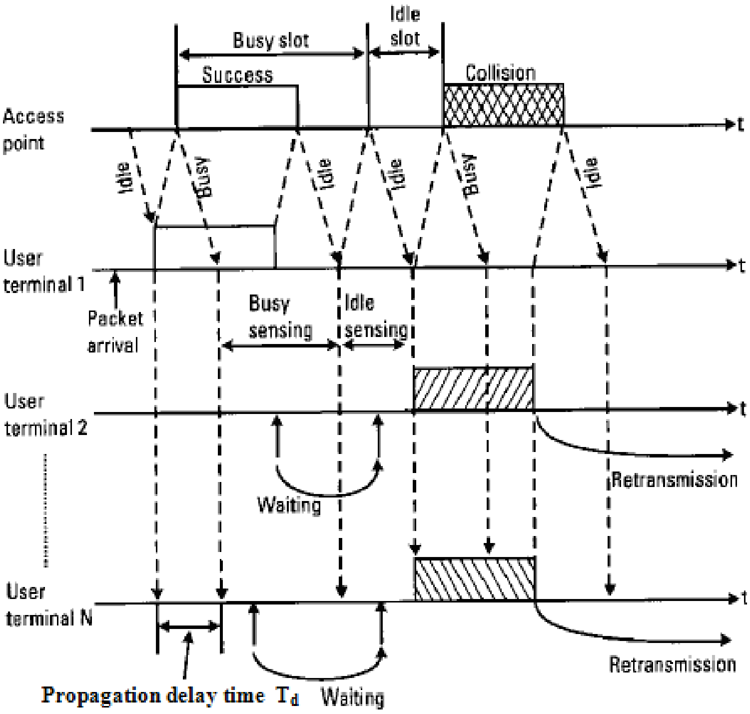

Fig (3) Slotted ... ISMA