Journal of the Society of Korea Industrial and Systems Engineering
Vol, 26, No. 2, pp.42－45, March 2003.

무선 PCS를 위한 수정된 자원경매다중접속에 대한 연구

김호준 · 윤상흠

전주대학교 정보기술컴퓨터공학부

A Study on the Modified Resource Auction Multiple Access for Wireless PCS

Ho-Joon Kim, Sang-Hum Yoon

School of Information Technology and Computer Engineering, Jeonju University

본 논문은 무선개인통신(PCS)환경에서 기존의 자원경매다중접속(RAMA)방법이 가지고 있는 단점을 보완할 수 있는 새로운 자원경매다중접속방법(MRAMA)을 제안하기 위한 것이다. 제안된 방법은 경매표 개념을 도입하여 슬럿 할당 주기 상에서 경매 슬럿(slot)을 낭비하는 단점을 보완할 수 있으며, 할당 주기마다 갱신되는 경매테이블을 채택하고 선점 및 비선점 우선순위규칙이 혼합된 방법을 활용함으로써 빠르고 유연하게 접속, 핸드오프, 자원할당이 가능해진다. 본 논문에서는 다양한 환경에서의 시뮬레이션을 통해 제안된 MRAMA방법이 기존의 RAMA에 비해 더 향상된 성능을 보이고 있음을 증명한다.

Keywords : modified resource auction multiple access, wireless PCS, slot assignment

1. Introduction

Wireless communication has become an important fileld in the mobile telecommunication era. One problem associated with the wireless communcation is that the system bandwidth is limited. To provided huge multimedia services to many users with limited bandwidth, an efficient multiple-access(MA) scheme is required. Reservation-based time-devision MA(TDMA), Dynamic TDMA(D-TDMA), Packet reservation multiple access(PRMA), and Resource auction multiple access(RAMA) have been extensively studied as a efficient multiple access schemes[4][6].

The RAMA was proposed by Amitay[1] to address the need for fast and flexible access, handoff and resource assignment in future high capacity wireless personal communication system(PCS). And Amitay and Greenstein[2] have examined the effects of channel fading and noise, considering both GSM and IS-54 cellular environment in RAMA. Also Amitay and Nanda[3] have evaluated the performance of RAMA for statistical multiplexing of speech.

X. Qiu and V. O. K. Li[8] have studied differenct reservation-type multiple aceess schemes such as D-TDMA, PRMA, and RAMA. They have observed that RAMA provides the best voice performance at the expense of slightly degraded data performance and that the data traffic load has no influence on the voice performance.

These studies have an advantage that no communication resources are missed due to collisions by using deterministic algorithm. However there have been no concern on the problems of wasted auction slots in the auction process of RAMA. Because the assignment cycle, which consists of the fixed length auction period and the resource assignment period, is repeated until the auction process terminates and for each cycle the auction period is much longer than the resource assignment period, the wasted auction slots cause the performance of RAMA to be significantly degraded. It can be noted that

each auction period is being wasted due to the fact that the base station does not utilize the previously obtained list of the users involved in the auction.

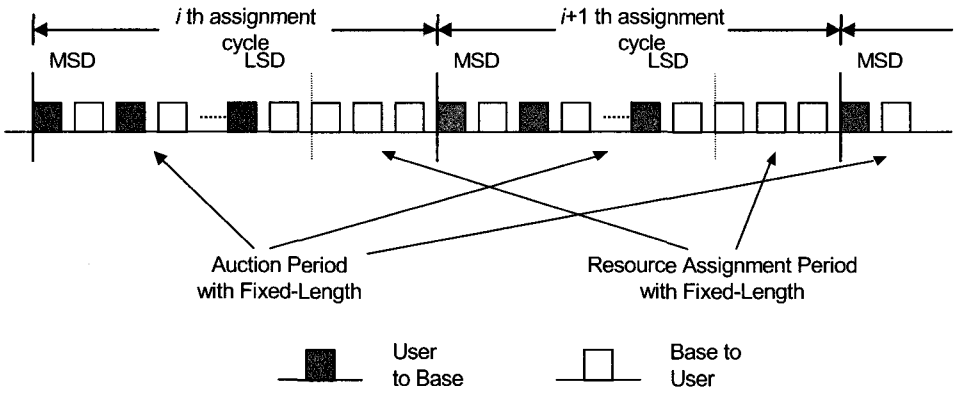
In this paper, a modified resource auction multiple access(MRAMA), which adopts the auction table and the combined preemptive-nonpreemptive priority scheme, in which the auction table is updated in parallel with resource assignment period, is proposed and analyzed. We introduce the auction table in order to overcome the disadvantages of RAMA and increase the number of handoffs/assignments per second. We also newly applied the combined scheme of preemptive and nonpreemptive priority[5][7] to meet the need of fast and flexible access, handoff, and resource assignment in wireless PCS.

2. Modified RAMA

The proposed MRAMA, which combines random and reservation multiple access scheme, is operated as a conflict free protocol by using auction table and also as a contention protocol by using combined preemptive-nonpreemptive priority scheme.

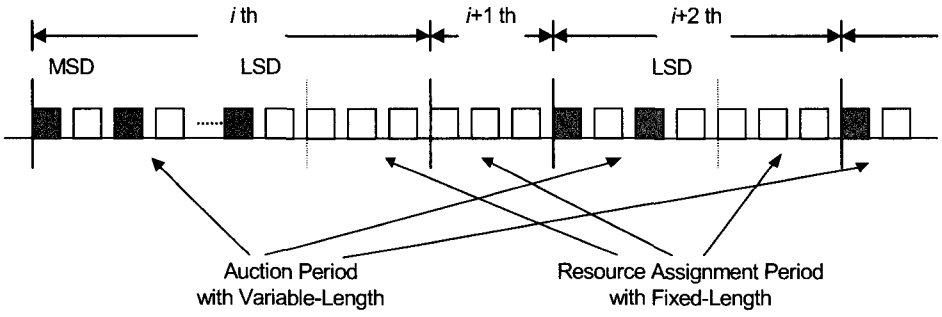
In MRAMA,

(i) Auction table : Based on the previously obtained information in the auction process, the auction table can be constructed by the base station. At the end of ith assignment cycle, the base station has the list of ID of users taking part in ith auction. In the ID list, a full ID of users is appeared or, at least, the most significant digit is obtained. So the base station can construct the auction table by orderly rescheduling the users taken part in the ith auction. By using auction table, the base station can assign the resource to the winner of $i+1$ th assignment cycle without auction period. If there is no other user with high priority, the available communication resource is assigned according to the obtained auction table. In MRAMA, the as-



*MSD : Most Significant Digit, *LSD : Least Significant Digit

<Figure 1> Resource assignment cycle of RAMA



<Figure 2> Resource assignment cycle of MRAMA

signment cycle has the variable length in contrast to fixed length cycle of RAMA(See Fig.1 and Fig.2). Variable length auction period is used in MRAMA to prevent the waste of auction slots due to the use of fixed length auction period in RAMA. So the auction slots used in assigning the available resource to the users participating in auction are significantly reduced.

(ii) Combined preemptive-nonpreemptive priority schem e : If the resource assignment is strictly scheduled according to the auction table, it is difficult to carry out fast and flexible access, handoff, and resource assignment, that is the native properties of RAMA. So a combined preemptive-nonpreemptive priority scheme is adopted to maintain these properties. In MRAMA, the combined priority scheme is employed, as below, according to τ, the ratio of the elapsed time to the total time of the auction period.

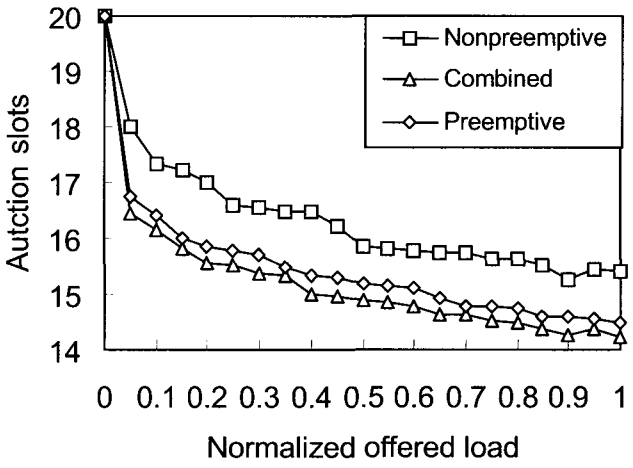
The preemptive priority scheme is employed in cases of (1) the higher priority user than the users in the auction table is arrived before the beginning of a new assignment cycle, (2) the higher priority user is arrived when the elapsed time for the lower priority user in the auction period is less than τ. Here the auction process of a low priority user is interrupted and continued after the resources allocation of the high priority users.

The nonpreemptive priority scheme is employed in cases of (1) the high priority user is arrived, when the elapsed time of the low priority user in the auction period is greater than, (2) the high priority user is arrived, after low priority user is assigned. Here high priority user moves ahead of low priority users in the auction table, but does not preempt lower priority user already in the assignment cycle.

3. Simulation Results

To verify the improvement of the proposed MRAMA, we simulated and compared its performance with that of RAMA. Amitay and Nanda assumed that each subscriber was represented by a nine digits-decimal number of social security number and additional priority digit. They used 4-digits decimal number to identify finite time slot number of the frame. To be consistent with previously published papers[2][3], we also initially assume a 10-digit decimal for a user ID and a 4-digit decimal for the assigned slot ID. We use MATLAB tool as a event driven simulator. The simulation has been performed for various normalized offered load. We simulate both the RAMA and proposed MRAMA under the same M-ary FSK, GSM parameters, and propagation delay, and assume that τ is 0.5.

In Fig.3, we have plotted the auction slots for the cases of nonpreemptive, preemptive and combined priority scheme. As can be seen in the figure, the number of auction slots can be reduced 18.97%, 23.45% and 25.14% for normalized offered load of 0.45 respectively. For various values of normalized offered load, the performance of combined priority scheme is always superior to those of preemptive and nonpreemptive priority scheme. So the combined priority scheme is an effective method to assure the fast resource assignment.



<Figure 3> Auction slots against normalized offered load for nonpreemptive, preemptive and combind priority scheme

We calculated the number of assigned slots per unit time, and compared MRAMA with RAMA for various values of M(the number of orthogonal signals in M-ary FSK) and propagation delay. Table 1 lists the number of handoff/assignments per 4.615 ms frame (and per second, in brackets) for propagation delays of up to 30 μs and the values of M ranging from 2 to 16. Using selected GSM parameters with RAMA, in microcells with propagation delays of 1 μs, 5.7(1,080) resource assignments per unit time are feasible; and with delays as high as 30 μs, 1.9(432) assignments per unit time are feasible. In MRAMA, as can be seen in Table 1, 7.1(1,512) and 2.5(432) resource assignments per unit time are feasible respectively when arrival rate is 0.3. Observe that, as expected, the number of auction slots can be reduced 19.2% and 29.2% for normalized offered load of 0.08 and 1 respectively.

<Table 1> Handoffs/Assignments per 4.615 frame

Propagation	M=2		M=3		M=4		M=8		M=16	
Delay(μs)	RAMA	MRAMA	RAMA	MRAMA	RAMA	MRAMA	RAMA	MRAMA	RAMA	MRAMA
1	5.1 (1,080)	6.3 (1,296)	5.7 (1,080)	7.1 (1,512)	5.4 (1,080)	6.7 (1,296)	3.9 (648)	4.8 (864)	2.6 (432)	3.2 (648)
5	3.8 (648)	4.7 (864)	4.5 (864)	5.6 (1,080)	4.5 (864)	5.6 (1,080)	3.5 (648)	4.3 (864)	2.5 (432)	3.1 (648)
10	2.8 (432)	3.5 (648)	3.6 (648)	4.5 (864)	3.8 (648)	4.7 (864)	3.2 (648)	4.0 (864)	2.3 (432)	2.8 (432)
15	2.3 (432)	2.8 (432)	3.0 (648)	3.7 (648)	3.2 (648)	4.0 (864)	2.9 (432)	3.6 (648)	2.2 (432)	2.7 (432)
20	1.9 (216)	2.4 (432)	2.6 (432)	3.2 (648)	2.8 (432)	3.5 (648)	2.7 (432)	3.3 (648)	2.1 (432)	2.6 (432)
25	1.6 (216)	2.0 (432)	2.3 (432)	2.8 (432)	2.5 (432)	3.1 (648)	2.5 (432)	3.1 (648)	1.9 (216)	2.4 (432)
30	1.4 (216)	1.7 (216)	1.9 (216)	2.5 (432)	2.3 (432)	2.8 (432)	2.3 (432)	2.8 (432)	1.8 (216)	2.3 (432)

4. Conclusions

The proposed MRAMA, which uses the hybrid random-reservation multiple access, can prevent the auction slots from being wasted by use of the previously obtained auction table and combined priority scheme, and thus yields significant improvement in performance compared with the RAMA. MRAMA always yields better throughput for various load under both ideal and real radio channel and significantly increased the number of handoffs/assignments per unit time. As results, MRAMA is expected to be applied as an efficient multiple access scheme for future high capacity wireless PCS.

References

[1] Amitay, N.; "Resource Auction Multiple Access (RAMA) : Efficient Method for Fast Resource Assignment in Decentralized Wireless PCS," Electronics Letters, 28(8) : 799-801, 1992.

[2] Amitay, N. and Greenstein, L. J.; "Resource Auction Multiple Access(RAMA) in the Cellular Environment," IEEE Transactions on Vehicular Technology, 43(4) : 1101-1111, 1994.

[3] Amitay, N. and Nanda, S.; "Resource Auction Multiple Access(RAMA) for Statistical Multi -plexing of Speech in Wireless PCS," IEEE Transactions on Vehicular Technology, 43(3) : 584-596, 1994.

[4] D. J. Goodman, D. J.; "Tends in Cellular and Cordless Communications," IEEE Communications Magazine, 2 9 : 31-40, 1991.

[5] Kleinrock, L.; Queueing Systems, Volume II : Computer Applications, Wiley, New York, 1976.

[6] Nanda, S., Goodman, D. J. and Timor, U.; "Performance of PRMA : A Packet Voice Protocol for Cellular Systems," IEEE Transactions on Vehicular Technology, 40(3) : 584-598, 1991.

[7] Schwartz, M.; Telecommunication Networks - Protocols, Modeling and Analysis, Addison Wesley, 1988.

[8] Xiaoxin Qiu, X., and O. K. L. Victor,; "A Unified Performance Model for Reservation-Type Multiple-Access Schemes," IEEE Transactions on Vehicular Technology, 47(1) : 173- 189, 1998.

Acknowledgement

This work was partly supported by grant from fundamental research program supported by Ministry of Information & Communication in republic of Korea.