셀룰라 시스템에서 멀티미디어 서비스를 위한 호 수락제어 기법 연구

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Call Admission Schemes for Multimedia Services in CDMA Cellular Systems

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요 약

본 논문에서는 셀룰러 시스템에서 다양한 특성을 갖는 멀티미디어 서비스에 우선순위를 각각 부여하여 효율적으로 제어하여 핸드오버 서비스나 신규 서비스에 대한 블록킹 확률을 최소화하는 호 수락제어 기법을 제안 하였다. 본 알고리즘은 비실시간 서비스들이 대역폭을 공유하는 Packing 방식, Queuing 방식, Power reallocation 방식의 호 수락 제어 방법에 관한 것으로 비실시간 서비스들의 트래픽 특성에 따라 공유 대역폭을 할당하고 남은 잉여 자원을 우선순위가 높은 실시간 서비스에게 제공하여 QoS를 보장하였다. 본 논문에서 성능판단 파라메타로는 블록킹 확률과 강제절단 확률을 설정하였고 다양한 형태의 멀티미디어 트래픽에 대해서 블록킹 확률과 강제절단 확률을 시뮬레이션을 통하여 각각 비교 분석 하였다.

Key Words : Cellular Systems, Admission Control, QoS, Blocking Probability

ABSTRACT

We propose a novel call admission control scheme which improves the handoff drop and the new call block probabilities of high priority services, minimizing the negative impact on low priority services, in multimedia service cellular networks. This paper proposes three schemes to solve this problem; the packing scheme in which available channels of a cell distributed to each frequency channel are concentrated on one frequency channel and a high transmission rate service is assigned to the frequency channel; the queuing scheme in which the queue is used for high transmission rate calls; and the power reallocation scheme in which the power assigned to calls under service is temporarily reduced and a high transmission rate service is allowed. The simulation results revealed that our scheme improved the drop and the block probabilities of the high priority services compared with the conventional scheme.

Ⅰ. Introduction

Future mobile communication systems are expected to handle a variety of data traffic types, including voice, data, facsimile, video and interactive information services. The characteristic of data traffic for multimedia service is that there is a variety of services with several Kbps ~ several Mbps in case of data transmission rate and 10^{-3} - 10^{-7} in case of Bit Error Rate (BER), and there is also a variety of services in-

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cluding a service requiring real-time transmission and a service allowing a considerable amount of delay in case of transmission delay time[1]. A great deal of researches have been made in order to provide effectively multimedia services requiring various characteristics[2][3][4]. The blocking probability of calls having a considerable affect on service quality may be varied greatly according to the data transmission rate. In cellular systems, a call is allowed when the available resource of air interface and the system is sufficient enough to support the transmission rate of a request call[5]. Therefore, compared to voice services or data services requiring a low transmission rate, services requiring high transmission rate such as image service, etc. will have a much higher blocking probability. Particularly, in CDMA cellular systems in which the assigned frequency zone is divided into many sub-channels, the difference of blocking probability of calls according to the transmission rate will be larger compared to those of TDMA or FDMA cellular systems[6][7].

In this paper, three schemes are proposed to solve the problem that the blocking probability of calls is varied according to transmission rate in CDMA cellular systems. The first is the packing scheme which admits a high transmission rate call by concentrating available channels of a cell distributed over each frequency channel to one frequency channel when any frequency channel can not afford to a high transmission rate service but the total capacity of a cell can afford to the call. The second is the queuing scheme. In this scheme, if there is no free channel, low transmission calls are blocked while high transmission rate calls are placed in the queue in First In First Out (FIFO) order. The third scheme is the power reallocation scheme that allows high transmission rate calls by temporarily reducing the power assigned to existing calls when high transmission rate calls can not be allowed in a normal way. It is also possible to combine and apply two schemes concurrently, which is also reviewed in this paper. Performance of the proposed schemes is analyzed by computer simulation and characteristics for the proposed schemes are compared.

This paper is organized as follows. Section II describes proposed call admission schemes for multimedia services, and a simulation model is described in section III. The simulation results of the conventional scheme and proposed schemes are evaluated and discussed in section IV, and conclusions are presented in section V.

Ⅱ. Call Admission Schemes for Multimedia Services

In this section, we describe a call admission control scheme favoring high priority services in multimedia service cellular networks. The proposed scheme is a mix of two strategies: *grouping* and *differentiated handoff region*[10].

Grouping. It reallocates the wasted bandwidth assigned to low priority services to incoming high priority services. It enables to accept the admission requests of high priority services even when there remains insufficient bandwidth in the cell. The scheme works as follows. When high priority services request the admission to a cell, but there is insufficient bandwidth remaining, the existing low priority services hand over their bandwidth in order to accept those requests. Instead, they form a bandwidth-sharing group in which they are able to continue their services by sharing the bandwidth in round robin. The bandwidth allocated to the group is much smaller than the total sum of the bandwidth owned by each group members.

Differentiated Handoff Region. It is devised to improve the handoff drop probability of high priority services over low priority services by adopting different sizes of handoff region according to the service priority. We set the handoff region of high priority services larger than that of low priority services. As a result, high priority services start the handoff procedure earlier and last longer than low priority services, leading to the improved handoff drop probability. In general, the handoff is performed by measuring the received signal strength(RSS) of the pilot channel emitted by the base stations[11][12]. The differentiated handoff region can be implemented by adopting different thresholds for services depending on their priorities. To enlarge the handoff region of high priority services, it needs to increase the handoff threshold, while decrease the receive threshold. On contrary, to shrink the handoff region for low priority services, it is accomplished by decreasing the handoff threshold and increasing the receive threshold. In our proposed scheme, we set the different RSS thresholds according to service priorities in such a way that for high priority services, the handoff region spans entire overlapped area between the call - departing cell and the call - arriving cell, while that of low priority services locates within the narrow area of the overlaid region. In the case of the departing cell, the RSS threshold that triggers the handoff of the high priority services is set higher than that of the low priority services, thus having the effect of starting the handoff of the high priority services earlier than that of the low priority services. The algorithm pseudo code that implements our proposed schemes is as follows. It shows how the two proposed schemes are related each other. New call request is handled by the grouping scheme first, then, when the call is about to perform the handoff, the differentiated handoff scheme takes effect.

```
New Call Admission Request to Cell A
if requested BW ≤ available BW of cell A then
   Accept the Request
else
   if The Request is High Priority Service then
      Perform the Grouping at Cell A
         if requested BW ≤ available BW of cell A after
         Grouping then
         Accept the Request
      else
         Reject the Request
end if
while RSS ≥ Handoff Threshold of Cell A do
   Keep Monitoring RSS
end while
   Handoff Request to Cell B  Handoff Procedure
if requested BW ≤ available BW of cell B then
   Handoff Success to Cell B
else
   if The Request is High Priority Service then
      Perform the Grouping at Cell B
         if requested BW ≤ available BW of cell B after
         Grouping then
         Handoff Success to Cell B
         if Find the Group with the Available Bandwidth
         then
            Handoff Success to Cell B
         else
         Wait in the Handoff Queue of Cell B
         end if
      end if
      if RSS ≤ Receive Threshold of Cell B then
      Handoff Failure, Drop
      else
        Sort Requests in the Handoff Queue of Cell B
        Start the Handoff Procedure Again
      end if
end if
```

Packing-based admission scheme, it is a idle channel for a low transmission rate service searched from the highest loaded frequency channel among available frequency channels. By doing so, the blocking probability of a high transmission rate call can be reduced since some frequency channels will be maintained in a considerably low loading state.

Secondly, a request call will be rejected if available resource of every frequency channel is smaller than the capacity of the request call even though the total resource of the cell is larger than the capacity of a request call. In this case, as shown in Fig. 1, a high transmission rate service can be allowed by concentrating available channels of a cell distributed over each frequency channel to one frequency channel. Concentrating can be achieved by handoff the calls of the least loaded frequency channel to other frequency channels. In this case, affect on the service quality of existing calls can be minimized if delay insensitive calls are selected rather than delay sensitive calls in selecting calls to be handed off, because transmission errors for delay insensitive calls can be recovered by re-transmission of error frame.

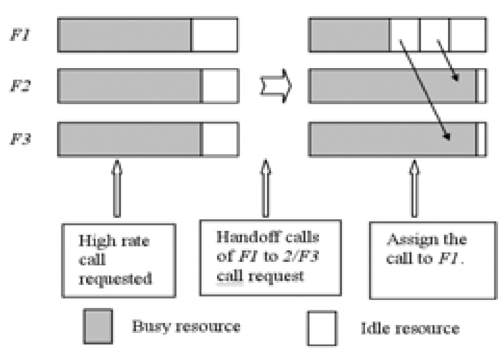

Fig. 1. Description of packing-based Call admission scheme

Power reallocation-based admission scheme, it is to admit call high transmission rate calls by reducing a portion of resources assigned to existing calls of least loaded frequency channel when a requested call can not be allowed in normal way. In CDMA cellular systems, the resource assigned to a call is determined by the power assigned to the call, and therefore, reducing of the resource assigned to existing calls is possible by decreasing required RSS or Eb/No value[6].

Queuing-based admission scheme, it is to use the queue only for higher data transmission rate calls. If there is no free channel, low transmission calls are blocked while high transmission rate calls are placed in the queue in FIFO order. Finally, it is possible to apply more than two schemes simultaneously by combining each scheme mentioned above. In other words, it is possible to apply simultaneously packing scheme and queuing scheme, or packing scheme and power reallocation scheme. It is expected that the case of simultaneous application will show superior characteristics compared to the case of sole application.

Ⅲ. Simulation Model

Performance analysis was done through computer simulation using two tired cell model which contains 19 cells and the assumption that handoff rate per call is much smaller than two[8]. The following assumptions were made in simulation. New calls are arrived in Poisson distribution with a mean λ calls/sec in a cell and calls are uniformly distributed within a service area. The call duration time has an exponential distribution with a mean of 120 seconds[9] and each cell serves 3 frequency channels. The number of traffic channels of each frequency channel is 50 **assuming that bandwidth of frequency channel is 5MHz, continuous transmission data rate is 9.6 Kbps, required *Eb/No*=7dB and cell shape is omni-cell[7]**. Two types of calls are assumed, 9.6 Kbps calls and 128 Kbps calls. 9.6 Kbps is the transmission rate of voice service used in mobile communication such as QCELP and ACELP and 128 Kbps service which is the higher rate among those of services guaranteeing mobility. A 9.6 Kbps call occupies one traffic channel per call and a 128 Kbps call occupies 13 traffic channels per call. The radius of a hexagonal cell, *R,* is 3 km[9], outer radius of a cell including soft handoff area of a self cell, *Rout,* is 3.3 km, and inner radius of a cell indicating the soft handoff region of an adjacent cell, *Rin,* is 2.7 km. The ratio of soft handoff region with respect to the entire cell area under these conditions is 20 percent. The speed and direction of a mobile are evenly distributed in the interval of [0, 90 km/hr] and [0, 2π], respectively, and are not changed during service[9] and finally, the mobile station is reflected internally upon reaching the outermost boundary of 19 cell group.

Ⅳ. Simulation Results and Discussions

4.1 Blocking probability of conventional scheme

Fig.2 and Fig.3 show the blocking probability of calls according to the data transmission rate and the operation of assigned frequency zone. In case of data transmission rate, two types of services, 9.6 Kbps and 128 Kbps service are examined. The ratio of 128 Kbps calls to the total calls was examined for 10 percents and 20 percents, and an average service time of two services was assumed to be as 120 seconds identically. For operation of assigned frequency zone, two cases were examined ; one case is that a assigned frequency zone is operated in one frequency channel and the other case is that a assigned frequency zone is divided into three frequency channels. It was assumed that the number of traffic channels of a cell was 150, and there were 50 traffic channels for each frequency channel in case the frequency zone was divided into three frequency channels. In case of using three frequency channels, calls were assigned to each frequency channel with a circular method. As shown in Fig.2 and Fig.3, the blocking probability of 128 Kbps service were much higher than that of 9.6 Kbps services. For frequency operation, the case that assigned frequency zone is divided into three frequency channels shows a higher blocking probability for 128 Kbps services than the case that assigned frequency zone is used only one frequency channel. Whereas, for 9.6 Kbps services, the case of using three frequency channels shows a lower call blocking probability compared to the case of using one frequency channel. Showing a lower

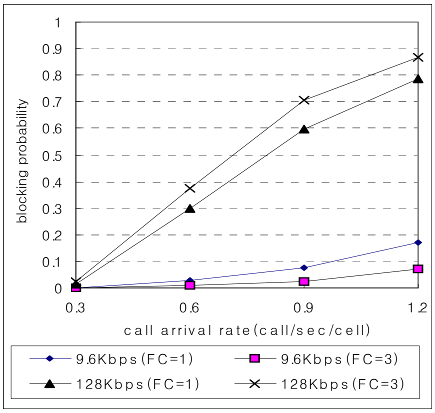

Fig. 2. Blocking probability of calls in the conventional schemes.

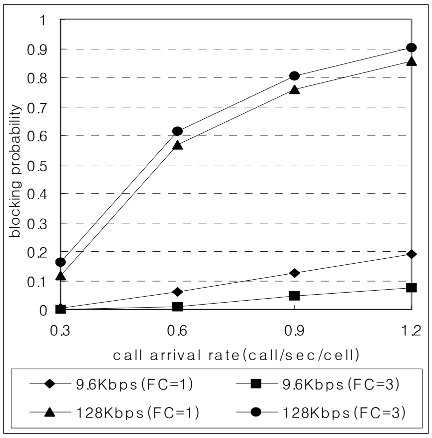

Fig. 3. Blocking probability of calls in the conventional schemes

blocking probability of 9.6 Kbps services in case of using divided frequency zones is a natural consequence of increased blocking probability of 128 Kbps service. Accordingly, in CDMA cellular systems in which a service zone was divided into several frequency channels, the difference in blocking probability of calls according to a data transmission rate was shown to be greater compared to those in case of TDMA or FDMA cellular systems.

4.2 Blocking probability of calls of the proposed scheme

The blocking probability of calls in the proposed schemes is shown in Fig.4 and Fig.5. It was assumed that the number of frequency channels served in each cell was 3, and the number of traffic channels of each

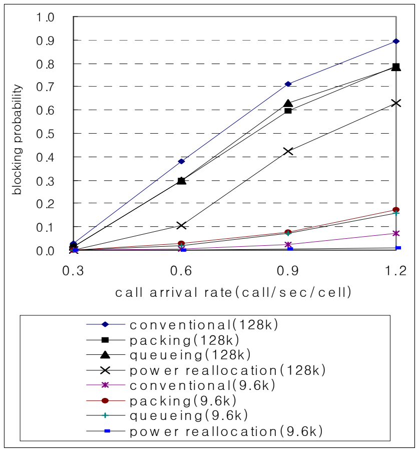

Fig. 4. Blocking probability of calls in the proposed schemes

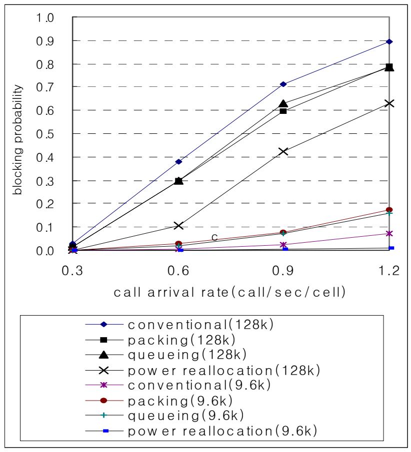

Fig. 5. Blocking probability of calls in the proposed schemes.

frequency channel was 50. Two types of services were assumed 9.6 Kbps and 128 Kbps. The ratio of 128 Kbps calls was examined for 10 percents and 20 percents, and an average service time of two services was assumed to be identical as 120 seconds.

In queuing scheme, it was assumed that maximum queuing time was 25 seconds considering the time handoff calls dwell in soft handoff area, the number of queue was infinite and FIFO (first-in-first-out) scheme was applied in the operation of queuing. In power reallocation scheme, 30 percent of allocated power was reduced for all existing calls at the time of applying the algorithm. Performance characteristics are not changed regardless of increase of traffic loads and difference of blocking probability according to a data

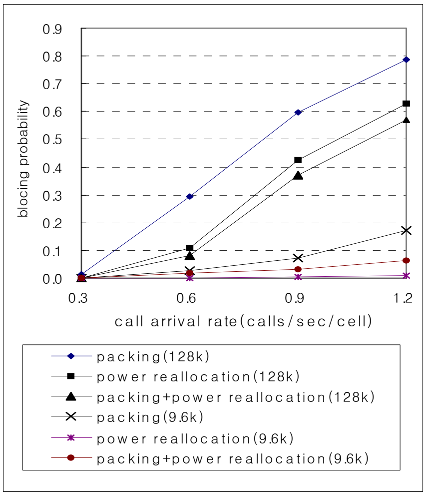

Fig. 6. Blocking probability of queuing scheme and packing schemes

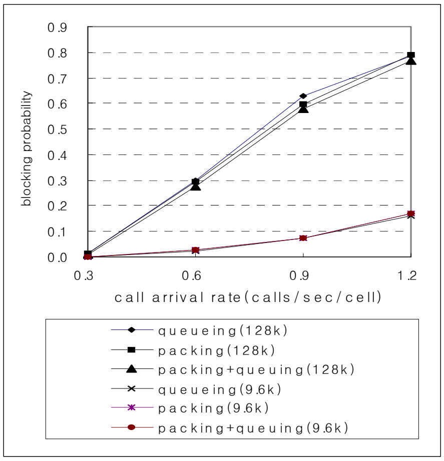

Fig. 7. Blocking probability of packing scheme and power reallocation schemes

transmission rate increases as traffic loads or the ratio of 128 Kbps services increases. The several schemes analysis shows considerably improved performance compared to the conventional scheme, but still showed a large difference in blocking probability of calls between services having different transmission rates. Therefore, for the purpose of more improved performance, the blocking probability of calls when two schemes were simultaneously applied was analyzed. Fig. 6 shows performance when the method of combining the packing scheme and the queuing scheme was used. That is, the packing scheme is applied first if admission of 128 Kbps service is not possible in normal call assigning procedure, and further the queuing scheme is applied if admission of the call is not yet possible despite of the packing scheme. The ratio of 128 Kbps services was 10 percents and the other conditions are equal to the case of applying each scheme separately. It was shown that the combined application of two schemes showed slightly superior characteristics compared to the case of applying each scheme separately. Fig. 7 shows the blocking probability of calls when the packing scheme and the power reallocation scheme were simultaneously used. That is, it is a scheme of applying the packing scheme first if admission of a call is not possible at the time of receiving a call of 128 Kbps, and further applying the power reallocation scheme if admission of the call is not yet possible. The ratio of 128 Kbps calls was 10 percents and the other conditions are equal to the case of applying each scheme separately. Also in this case, it was shown that simultaneous application of two schemes showed superior characteristics compared to the case of applying each scheme separately.

V. Conclusions

In this paper, we propose several scheme to support QoS, which the packing scheme, the queuing scheme, and the power reallocation scheme. Performance analysis was done for 9.6 Kbps and 128 Kbps transmission rate services. The results of analysis showed that all of the proposed schemes showed reduced blocking probability of calls compared to the conventional schemes for 128 Kbps services. Among proposed three schemes, the power reallocation scheme showed the most superior performance, and the packing scheme and the queuing scheme showed nearly equal performance. And the result showed that performance can be improved by combing two schemes simultaneously. As conclusions, the packing scheme in which only data calls are handed off are the most desirable in the case that a priority is given to minimizing the affects on existing calls.

While the power reallocation scheme is desirable if a priority is given to reduction of blocking probability for high data transmission rate services. The queuing scheme can be additionally added for both cases.

Finally, further studies are needed combining proposed schemes and priority handoff scheme.

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