Dynamic Channel Reservation for Mobility Prediction Handover

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Abstract: This paper suggests the effective channel assignment scheme for mobility prediction handover. For maintaining required quality of service (QoS) during handover, there are handover algorithms these reserve the channel where the movement is predicted. But channel assignment schemes these have been studied are not considered mobility prediction handover. This paper suggests the channel assignment scheme that considers mobility predicted handover. The suggested algorithm maintains dropping probability of handover calls, decreases blocking probability of new calls and increases channel utilization.

1. Introduction

The future personal communication network (PCN) is supposed to support multimedia services with various quality of service (QoS). The multimedia services that the future PCN is expected to support vary from low-rate data up to 2 Mb/s video. To support such broadband services, it is important to effectively utilize the scarce wireless resources by employing microcells or picocells[1].

Handover is a process whereby a mobile station communicating with one wireless base station is transferred to another base station during a call (session). A wireless mobile call in progress could be forced to abort during handover if it cannot be allocated sufficient resources in the new wireless cell. A cell is the radio coverage area of a wireless base station. Forced termination of an on-going call due to handover is more undesirable, from a user's perspective, than rejecting a new call. Reserving resources for future handover calls is an effective way to reduce the handover call-dropping probability [2].

Researches on channel assignment schemes have been made to reduce dropping probability of handover calls, and on handover algorithm that, in order to ensure QoS for handover, reserve channels where the movement is predicted[3].

Those handover priority schemes can reduce dropping probability of handover calls, and hence ensure QoS for the users, but, on the other hand, increase blocking probability of new call and use the BS resources in an inefficient manner. The Dynamic Channel Reservation Scheme (DCRS) is the one that increases overall channel utilization by increasing the dropping probability of handover calls to a certain degree, while reducing blocking probability of new call[4]. Those channel assignment schemes, however, are not considered for mobility prediction handover. Because the predicted handover call is pre-assigned with a channel in mobility predicted handover, the dropping probability of handover call decreases far below the required level, while the blocking probability of new call increases, decreasing overall channel utilization. In this paper an efficient channel assignment scheme for mobility predicted handover is suggested.

2. Channel Assignment Scheme

2.1 Fully Shared Scheme (FSS)

In fully shared scheme (FSS), the BS handles the call requests without any discrimination between handover and new calls. All available channels in the BS are shared by handover and new calls. Thus, it is able to minimize rejection of call requests and has the advantage of efficient utilization of wireless channels. However, it is difficult to guarantee the required dropping probability of handover calls, which is less desirable than restricting attempts of new calls for continuity of handover calls [4].

2.2 Guard Channel Scheme (GCS)

In guard channel scheme (GCS), which gives higher priority to handover calls than new calls. In GCS, a number of wireless channels, called guard channels, are exclusively reserved for handover calls, and the remaining channels, called normal channels, can be shared equally between handover and new calls. Thus, whenever the channel occupancy exceeds a certain threshold, GCS rejects new calls until it goes below the threshold. Handover calls are accepted until the channel occupancy goes over the total number of channels in a cell. It offers a generic means to decrease the dropping probability of handover calls but causes reduction of total carried traffics. The reason total carried traffic is reduced is that fewer channels except the guard channels are granted to new calls. The demerits become more serious when handover requests are rare. It may bring about inefficient spectrum utilization and increased blocking probability of new calls in the end because only a few handover calls are able to use the reserved channels exclusively [4].

2.3 Dynamic Channel Reservation Scheme (DCRS)

In dynamic channel reservation scheme (DCRS), both handover and new calls share equally the normal channel, which are radio channels below the threshold. The guard channels, the remaining channels above the threshold, are reserved preferentially for handover calls in order to provide their required QoS. Those channels, however, can also be allocated as much as the request probability for new calls instead of immediately blocking, unlike GCS. Thus handover calls can use both normal and guard channels with probability one if these channels are available. New calls use normal channels with probability one, but guard channels can be used for new calls according to the request probability. It contributes to reducing the blocking probability of new calls and improving the total carried traffic. Figure 1 shows this.

The request probability reflects the possibility that the BS permits new calls to allocate the wireless channel among the guard channels. It is dynamically determined by the probability generator in which the request probability is computed considering the mobility of calls, total number of channels in a cell, threshold between normal channels and guard channel, and current number of used channels. Among these factors, the mobility of calls is important. The mobility of calls in a cell is defined as the ratio of the handover call arrival rate to the new call arrival rate[4].

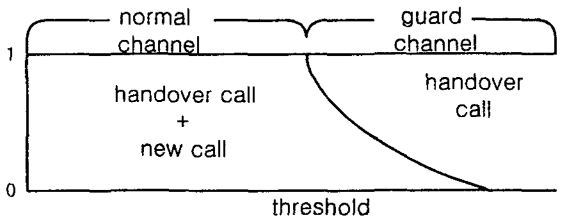

Figure 1. Channel allocation of DCRS

3. Mobility Prediction Dynamic Channel Reservation Scheme

In DCRS scheme, the mobility predicted handover is not considered. Channel reservation for the predicted handover can be made on a normal channel. In this case, because the predicted handover is reserved on a normal channel, the call dropping fewer and the dropping probability of handover calls lower than the expected level. On the other hand, because many normal channels are reserved for predicted handover calls, the blocking probability of new calls gets higher than the required level, and therefore, utilization of the total number of channel gets worse.

The Mobility Prediction Dynamic Channel Reservation Scheme (MPDCRS) adjusts the size of guard channel in accordance with prediction ratio of handover calls and consider feature of the mobility predicted handover. The suggested scheme maintains the dropping probability of handover calls in the required level, reducing blocking probability of new call and increasing overall channel utilization. In other words, because it is possible to reserve normal channel for predicted handover calls, the number of the guard channel is decreased and overall channel utilization is increased. The handover calls and new calls share normal channel. In the guard channel, which is outside the threshold, new calls are not directly blocked but are assigned with guard channels depending on the Request Probability (RP) of the new call calculated by the probability generator. (Fig 2)

RP for new calls is the parameter that determines assignment of wireless channels to the new call. In other words, handover calls are available at all times if the cell has free channels irrespective of normal channel or guard channel. On the other hand, new calls are assigned with the channel under the same conditions as handover calls in normal channel, but in guard channel, the new calls are allowed depending on the probability value calculated by RP.

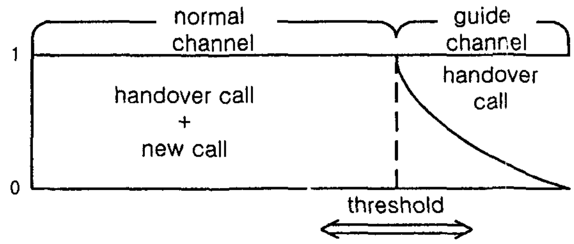

Figure 2. Channel allocation of MPDCRS

RP is determined based on the call traffic pattern, the number of available channels in the cell, the threshold that discriminates the normal channel from the guard channel, and the number of channels being used. The threshold that divides channels into normal channel and guard channel is determined by the handover prediction ratio, the ratio of predictable handover calls among entire handover calls. The formula to calculate RP for new calls in DCRS is as shown below Eq. (1).

$$RP = MAX\left\{0, \alpha\left[\frac{C-i}{C-T}\right] + (1-\alpha)\cos\frac{2\pi(i-T)^{\frac{1}{2}}}{4(C-T)}\right\} \qquad (1)$$

Where, C is the number of total channel in the cell, T is the threshold of normal channel and guard channel, i is the number of channels being used, and α indicates the call traffic pattern calculated in the following formula.

$$\alpha = \frac{\text{Number of new calls generated in the current BS}}{\text{Number of handover calls generated in the current BS}}$$

In MPDCRS, the threshold of the guard channel varies depending on the handover prediction ratio. The modified guard channel threshold is used in MPDCRS. Eq. (2) shows that used to calculate RP of new calls in MPDCRS.

$$RP = MAX\left\{0, \alpha\left[\frac{C-i}{C-T'}\right] + (1-\alpha)\cos\frac{2\pi(i-T')^{\frac{1}{2}}}{4(C-T')}\right\} \qquad (2)$$

Eq. (3) is the formula to calculate the threshold modified in MPDCRS.

$$T' = T + (C-T)(1-\beta) \qquad (3)$$

Eq. (4) indicates the formula for RP of new calls in MPDCRS.

$$RP = MAX\left\{0, \alpha\left[\frac{C-i}{\beta(C-T)}\right] + (1-\alpha)\cos\frac{2\pi(i-C+\beta(C-T))^{\frac{1}{2}}}{4\beta(C-T)}\right\} \qquad (4)$$

Where, β is the handover prediction ratio calculated in

$$\beta = \frac{\text{Number of predicted handover calls}}{\text{Number of total handover calls}}$$

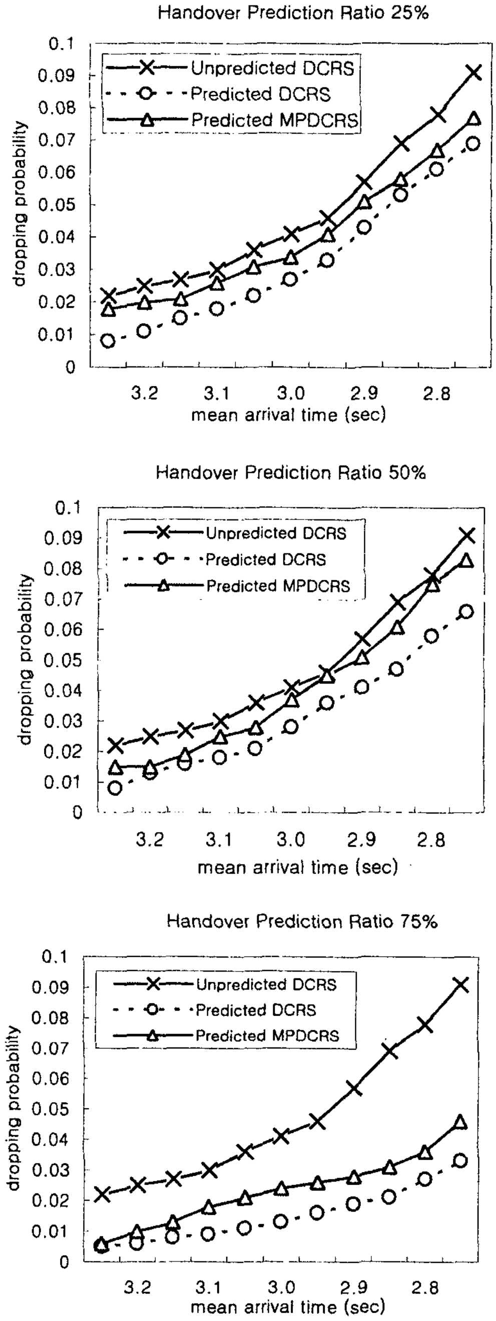

Figure 3. Dropping probability of handover call

4. Simulation Result and Analysis

We compare MPDCRS with DCRS in terms of dropping probability of handover calls, blocking probability of new calls, and channel utilization. We assume that the average number of mobile users is much bigger than the channels in the BS so that the net call arrivals to the BS are approximated as a Poisson process [4,5]. We assume that the total number of channel in a BS is 60 and all the wireless channels have the same fixed capacity [4]. The input parameters in our study are:

- λ : call arrival rate. Call arrive according to a Poisson process of rate λ [4,5].
- μ : the mean call completion rate. The call holding time is assumed to be exponentially distributed with a mean of $1/\mu$ [5].
- η : the portable mobility. The user residual time is assumed to be exponentially distributed with a mean of $1/\eta$ [5].

Figure 3,4,5 illustrates the effect of MPDCRS. The mean call holding time $1/\mu$ is 6 min, and the mean user residual time $1/\eta$ is 3 min. We assume that handover calls are 50% of total calls, and predicted handover calls are 25%, 50%, 75% of handover calls.

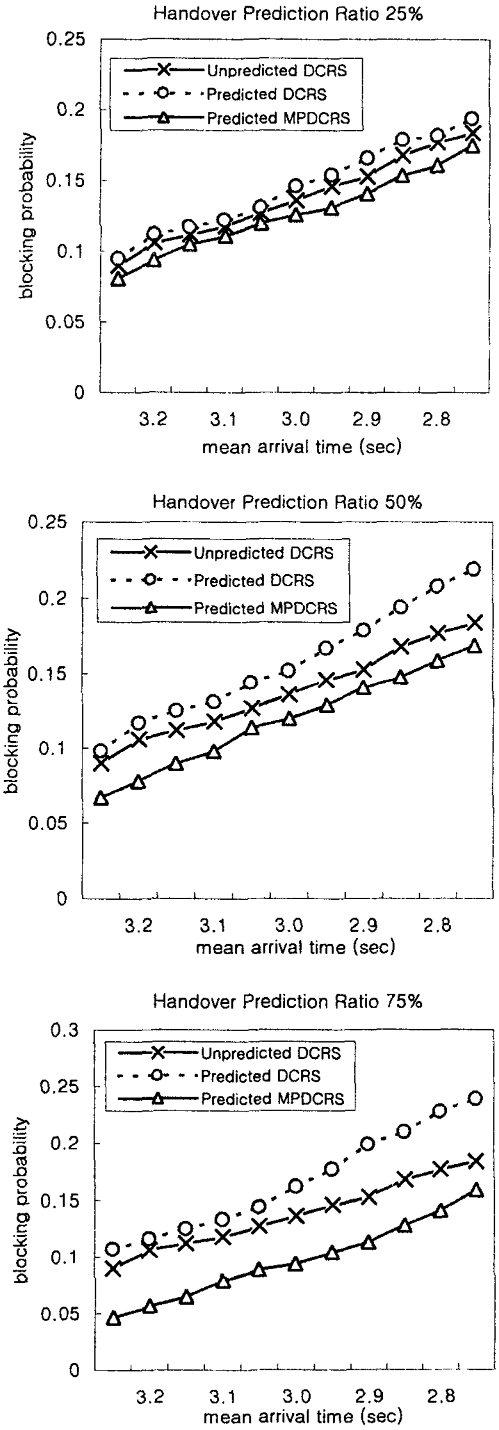

Figure 4. Blocking probability of new call

Figure 3 shows the dropping probability of the handover calls. The figure shows that the dropping probability of the mobility predicted handover is much lower than that of the unpredicted handover if DCRS is applied. When MPDCRS is applied, the dropping probability of the handover is adjusted between that of the unpredicted DCRS and that of the predicted DCRS. This is much clearer as the handover prediction ratio gets higher. The effect becomes greater as the handover prediction ratio gets higher.

Figure 4 shows the blocking probability of the new call. The figure shows that the blocking probability of the mobility predicted handover is a little lower than that of the unpredicted handover if DCRS is applied. When MPDCRS is applied, the blocking probability of the new call becomes much lower. The effect becomes lower as the handover prediction ratio gets higher.

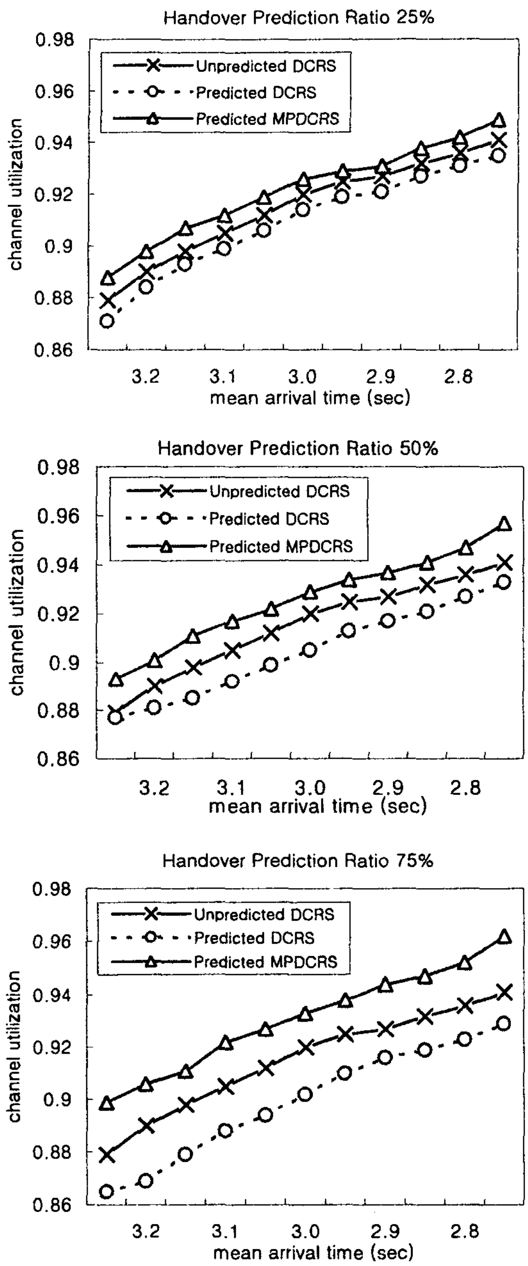

Figure 5. Channel utilization

Figure 5 shows the channel utilization. The figure shows that the channel utilization of the mobility predicted handover is lower than that of the unpredicted handover if DCRS is applied. When MPDCRS is applied, the channel utilization becomes higher. The effect becomes greater as the handover prediction ratio gets higher.

4. Conclusion

In this paper proposed MPDCRS as an efficient channel assignment scheme for mobility predicted handover.

If DCRS is applied, because normal channel is reserved for predicted handover calls, call drop of predicted handover calls is rare, and dropping probability of handover calls become lower than the expected level. On the other hand, the total channel utilization becomes deteriorated as predicted handover calls reserve normal channel. The proposed MPDCRS adjusts the guard channel size in accordance with the handover prediction ratio, maintains the dropping probability of handover calls, decreases the blocking probability of new calls, and increases channel utilization. Because normal channel is reserved for predicted handover calls, it is possible to increase total channel utilization by reducing the number of guard channel. Simulation proved that MPDCRS adjusts the dropping probability of handover calls, decreases the blocking probability of new calls, and increases the channel utilization. The effect becomes greater as the handover prediction ratio gets higher.

Acknowledgements

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