The Handover Algorithm That Considers The User's Mobility Pattern In Wireless ATM

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Abstract: This paper suggests the way to perform the handover by predicting the movement route of the mobile terminal by considering the movement pattern of the user. By considering the fact that the most users has the constant movement pattern, the channels needed for the handover can be reserved, and the required quality of service (QoS) is maintained during handover. The suggested algorithm makes the channel allocation schemes more efficient.

1. Introduction

With the increasing demands for mobile multimedia services, future wireless networks will adopt micro/pico cellular architectures in order to provide the higher capacity needed to support broadband services under the limited radio spectrum [1]. Due to its flexible bandwidth allocation, efficient multiplexing of burst traffic, and provision of a wide range of wireless broadband services, the wireless asynchronous transfer mode (WATM) network is a promising solution for the next generation wireless communication system. However, handover will occur frequently in wireless ATM networks because the cell size is much smaller to support higher capacity on the limited radio spectrum and to maintain the effectiveness of the channel in the high frequency band. Handover is the action of switching a call in progress in order to maintain continuity and the required quality of service (QoS) of the call when a mobile terminal moves from one cell to another. In the wireless environment, we need to consider two additional QoS parameters: dropping probability of handover calls and blocking probability of new calls from the standpoint of call-level QoS. From the subscriber's point of view, forced termination due to handover calls is less desirable than blocking of a new call. Therefore, the QoS of handover calls must be guaranteed while allowing high utilization of wireless channels [2].

If the handover is occurred frequently and QoS is not guaranteed, then the quality of the call can be lowered, or the call drop phenomenon can be occurred. Because of that reason, intensive research on channel allocation schemes has been in progress to reduce the handover dropping probability. Two generic handover prioritization schemes are queuing handover requests and reserving a number of channels exclusively for handover requests. In general, handover prioritization schemes result in decreased handover failures and increased call blocking, which, in turn, reduce total admitted traffic.

One priority scheme is the guard channel scheme(GCS), which gives higher priority to handover calls by assigning them a higher capacity limit to reduce the forced termination probability. GCS shares normal channels for handover and new calls, and reserves exclusively some fixed number of guard channels for handover calls [2]. Another priority scheme is the handover queuing scheme (HQS). In HQS, channels are reserved where handover is predicted. Handover requests are queued in the new cell if no channel is available in the new cell. New calls are served only when a wireless channel is available and no handover request exists in the queue [3].

However, there is a disadvantage that it is hard to find out the way of movement for the terminal. In the base station, the currently located cell or sector can be found out, but only the output of the electric wave be detected. Therefore, the additional messages are needed in order to find out the way of movement for the terminal. However, this can cause the waste of limited resource, and the terminal also needs the additional supplementary functions, but these functions can be even bigger than the basic function of the terminal.

By considering these facts, this paper suggests the handover algorithm by considering the movement pattern of the user. The suggested algorithm also makes the channel allocation schemes more efficient.

2. Effective Channel Assignment Schemes

2.1 Fully Shared Scheme

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]. However, if it is possible to predict the handover, dropping probability of handover calls can be lowered by assigning the cell channel beforehand that the handover will occur.

2.2 Guard Channel Scheme

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. Figure

1(a) shows this. 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 [2].

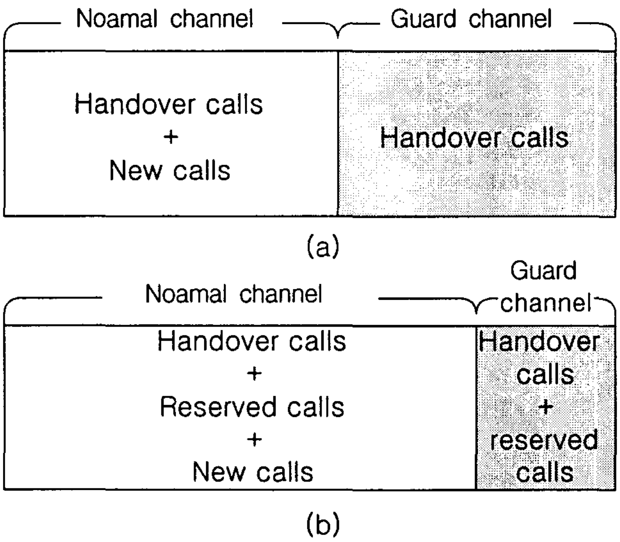


Figure 1
(a) Channel allocation of GCS
(b) Channel allocation of proposed method

If it is possible to predict the handover sufficiently, the channel for the predicted handover call is possible to be assigned beforehand, so the guard channel can be left a little bit. The guard channel is used for the unpredicted handover call and for the reservation of the predicted handover call if the normal channel is in shortage. Since the guard channel decreases, the efficiency for the channel increases. This is illustrated in figure 1(b).

3. Mobility Predicted Handover Algorithm

3.1 Mobility Pattern

The most users have the constant movement pattern. This pattern is not same, but this is different for each person. The subscribers have the constant pattern for daily, weekly or monthly basis. For example, in case of the employees, they usually have the pattern for daily. They go to the office, and work at the office, and go to the home, every day. The time for the pattern is also similar, and the movement pattern is different only during the weekend. In case of the active business man, they go to the office, and move for business, and return to office or go to home. The business man can move for business reason, and this route can be a lot of ways. In case of the student, the way of movement and the time have the constant pattern for each day of the week. They go to school, and stay at school, and go to home.

On the other hand, the taxi drivers can have various movement routes without having constant movement pattern. However, these cases do not occupy a lot of portion among the whole users, so this paper will not consider these cases.

The parameter that illustrates the movement principle for these users are called the Mobility Principle Element (**MPE**), and it illustrates that the subscriber moves constantly in the daily, weekly, or monthly basis.

The suggested way stores this movement pattern in the database. The database makes the multi-path possible by using the link structure, so that it is possible to provide a number of ways of the movement pattern. In the database, the cell number, the probability of movement, the staying time and the next moving cell number are recorded in database cell. Figure 2 shows the structure of database cell. The probability of movement can be found by analyzing the movement pattern of the previous period of the subscriber.

Current cell number	
average staying time T_{stay_ave}	
minimum staying time T_{stay_min}	
count of cells that are possible to move (n)	
Next Cell No(1)	Probability of movement $P_{move}(1)$
:	:
Next Cell No(n)	Probability of movement $P_{move}(n)$

Figure 2. Structure of the database cell of DBL

Linked database cell is called DataBase Link (**DBL**). It presents the usual movement pattern of the user. Figure 3 shows example of **DBL**. For the user who has the constant movement pattern every day, he or she has only one **DBL** of the movement pattern. For the user who has the constant movement pattern every week, he or she has **DBL** for the day basis. For the user who has the constant movement pattern for the weekdays or the weekends, he or she has the different **DBL** depending on the weekdays or the weekends. And for the user who has the constant movement pattern for the monthly basis, he or she has **DBL** for each date. Among **DBL**'s for the users who have **DBL** for each date or each day, the similar ones can use the same date or day.

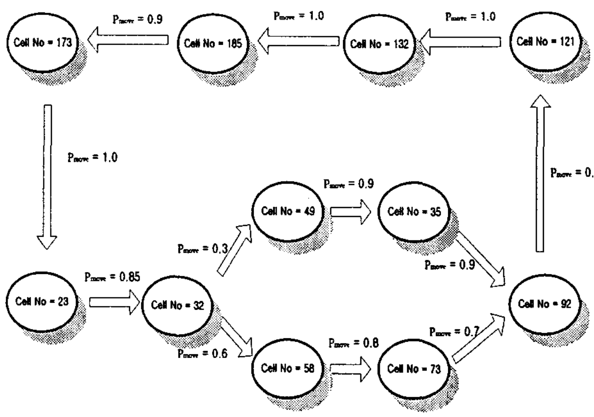


Figure 3. Example of DataBase Link (DBL)

3.2 Handover Algorithm

In case of the handover of the user, the handover algorithm that considers the user's mobility pattern for preventing the low QoS or the call drop caused by the lack of the used resource is like the following.

When the user starts to call, refer **MPE** that indicates the user's movement pattern, and determine **DBL** according to **MPE** of the user.

In determined **DBL**, refer the average staying time(T_{stay_ave}) and the minimum staying time (T_{stay_min}) in the currently located cell of the mobile subscriber. If T_{stay_ave} is greater than or equal to the average call continuation time (T_{call_ave}) for the user and T_{stay_min} is greater than or equal to the critical value of the minimum staying time (V_{stay_min}), the user terminates the handover algorithm by acknowledging that the handover is not made in the current location. V_{stay_min} can be found through the experiment by finding out the characteristics of the users.

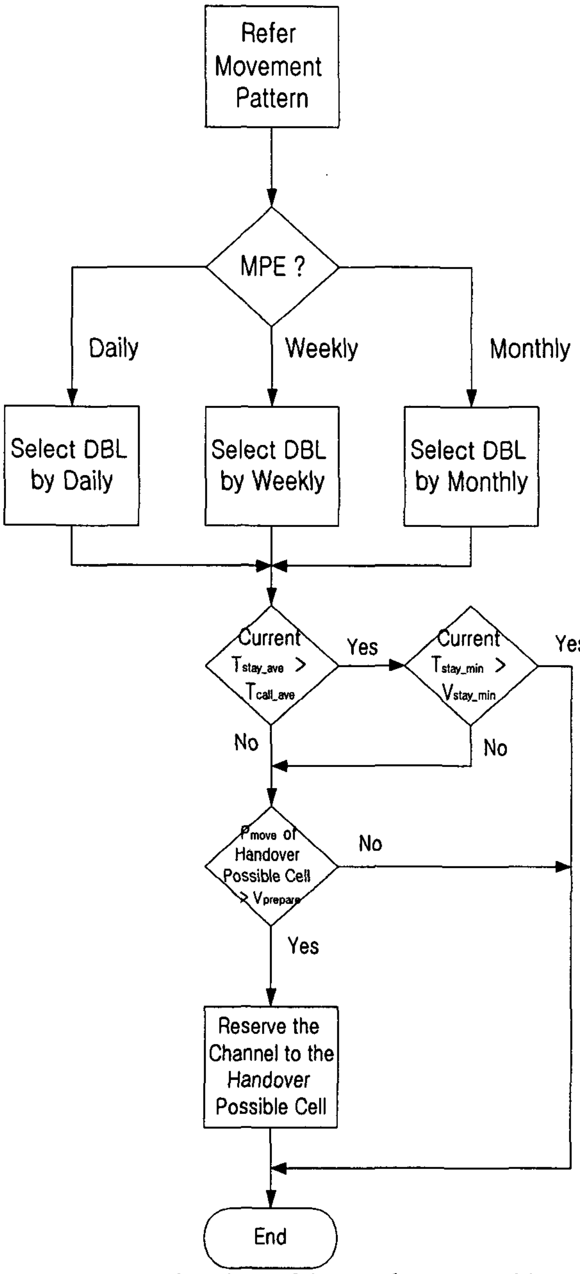
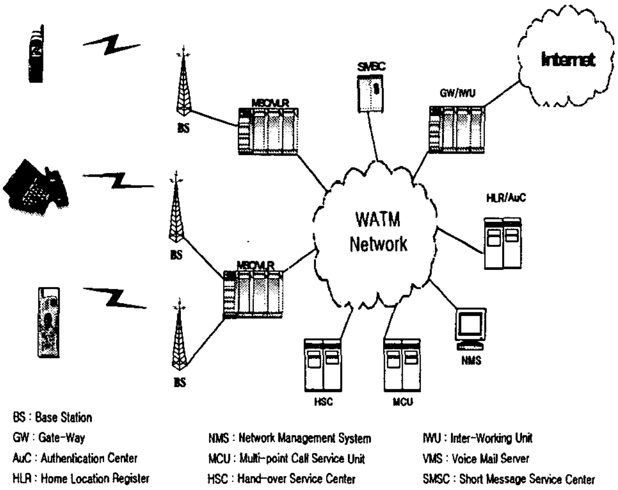


Figure 4. Flowchart of the Handover Algorithm

If T_{stay_ave} in the currently located cell is smaller than T_{call_ave} for the user, find the probability of movement (P_{move}) of the cells that are possible to move in **DBL** of the movement pattern. If this P_{move} is greater than the critical value for the movement preparation($V_{prepare}$), reserve the resources needed for the cells that are possible to move and get ready in case of handover. If the handover is occurred because of the movement of the user, execute the handover quickly by using the reserved resource, and prevent low QoS or call drop. $V_{prepare}$ is determined by the operator, and if this value is large, the QoS cannot be guaranteed, but the effectiveness for using the resource will be higher. If $V_{prepare}$ becomes smaller, the QoS will be guaranteed, but the effectiveness for using the resource will be lower. Therefore $V_{prepare}$ should be determined by considering the effectiveness for using the resource of the whole network. Figure 4 shows flowchart of the handover algorithm that considers user's mobility pattern.

4. Composition of The Network

In the wireless ATM network, the way to use the suggested handover algorithm is illustrated in the figure 5. Since the next generation network has the open architecture, a lot of network components are connected to the core network. Currently, the functions that are concentrated in the switching system except the basic switching are distinguished as the supplementary equipment, and they are connected so that it can have the architecture that is easy to develop and extend the network.



. Figure 5. Architecture of the network that implements the handover algorithm

The suggested algorithm is executed by Handover Service Center (**HSC**) that is connected to the wireless ATM network. HSC executes the handover during the movement when the wireless ATM terminal has the call connection, and it executes the role to find out the movement characteristic of the terminal during the movement of the terminal's location.

In the example of the figure 6, if the terminal attempts the call in the cell 2, the terminal connects the call by assigning the channel that is needed to the channel. In this state, the network follows the movement pattern of the terminal by using HSC. It finds out that the cell to be moved is cell 3, and it finds out that the conditions for the handover algorithm of the mobility prediction are satisfied. Then, reserve the channel (wired and wireless resource) that are used in cell 3, and prepare the handover. If the wireless ATM terminal is moved to the area of cell 3, the network connects the call by using the reserved channel, so that the call can be maintained without lowering QoS.

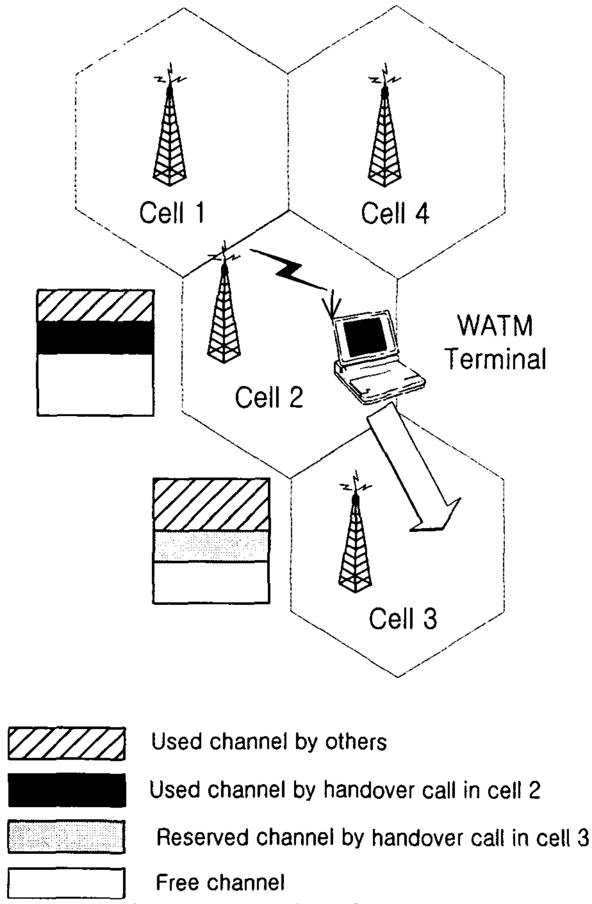


Figure 6. Execution of the handover according to the movement of the terminal

5. Conclusion

In this paper, we proposed the handover algorithm that considers the user's mobility pattern. Since most user have the constant movement pattern, the suggested algorithm predicted the movement path of the movement terminal by considering the movement pattern of the user. The user reserves the channel needed for the handover in the predicted cell. When handover is occurred, the call is connected by using the reserved channel. It is possible to maintain Oos of the call even in the case where the handover occurs frequently like the wireless ATM.

The suggested method makes the channel allocation schemes more efficient. In fully shared scheme (FSS), since the handover is possible to be predicted, dropping probability of handover calls can be lowered by assigning the cell channel beforehand that the handover will occur. In guard channel scheme (GCS), it is possible to assign the channel for the predicted handover call beforehand, the guard channel can be left a little bit. The guard channel is used for the unpredicted handover call and for the reservation of the predicted handover call if the normal channel is in shortage. Since the guard channel decreases, the efficiency for the channel increases.

Furthermore, by adjusting the critical value for the movement preparation ($V_{prepare}$), the use of effective network resource and guaranteeing QoS is adjusted by the resources that the network have, and the used amount of the user.

Acknowledgements

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