Project	**IEEE 802.20 Working Group on Mobile Broadband Wireless Access** **<http://grouper.ieee.org/groups/802/20/>**
Title	**Handoff procedure for MBWA system**
Date Submitted	**2003-09-13**
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Re:	MBWA Call for Contributions--Session #4, Sept 15, 2003
Abstract	This document addresses two kinds of basic handoff procedures for MBWA system. And it serves the purpose of defining the handoff procedures both break-before-make and make-before-break scenarios in order to minimize handoff delays with minimum or no packet loss, and of clarifying some details about the handoff.
Purpose	Discussion and Adopt
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1. Introduction

MBWA is a system to have the ability to support various vehicular mobility classes up to 250Km/h in a MAN environment. So it is important to remember that handoff is the main feature of cellular mobility.

According to the <802.20 requirement document –Rev6>, the handoff methods are required in MBWA systems to facilitate providing continuous service for a population of moving Mobile Stations (MS). Mobile stations may move between cell, between systems, between frequencies, and at the higher layer between IP Subnets. At the lowest layers, handoffs can be classified as either the break-before-make or the make-before-break handoff, depending on whether there is momentary service disruption or not.

When moving from a serving cell (old cell) to a target one (new cell), a MS has to firstly initiate an access procedure to the target BS in order to adjust its transmission power and timing with the target BS. Either make-before-break handoff or break-before-make handoff will have the access procedure for this aim.

When accessing the new cell, if it is contention-based to access the BS, the MS has to contest the access resource with all the other users who handoff from neighbor cells and initial users in the local cell. We expect the handoff procedure to be successful under most circumstances. However, several factors can unexpectedly interrupt the handoff procedure, for example the MS maybe fails to access the target cell because of the insufficient access resources.

This document serves the purpose of defining the handoff procedures both break-before-make and make-before-break scenarios in order to minimize handoff delays with minimum or no packet loss.

2. Partitioning of the Access Resources

To cater for the handoff method in this document, a method of access resources partitioning shall be considered. Generally the access resources in a frame can be divided into two parts: one for the initial access users in the local cell and the other for the handoff users from neighbor cells. For example, 30% of the access resources can be used by the handoff users, while 70% used by the users in the local cell. The method of access resources partitioning can be in frequency domain, code domain, time domain or combination of any of them. Four possible instances are shown in the following.

Figure 1 illustrates the time domain partitioning method, where the parameter ‘n’ means the total number of the access resources in a cell and ‘k’ is the split point between the access resources for initial users and those for the handoff users. So the access resource ‘1’ to the access resource ‘k’ shall be shared by initial users who trigger the random access procedure, while the access resource ‘k+1’ to ‘n’ used by handoff users.

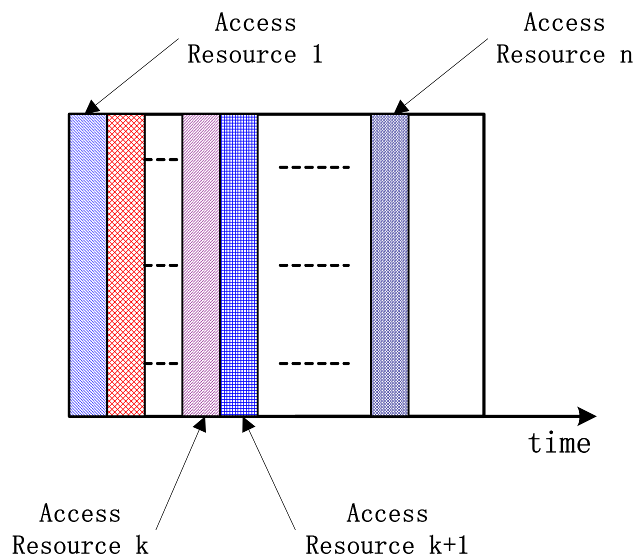

Figure 1 Access resources partitioning in Time domain

In the illustrative examples shown in Figure 2 and Figure 3, which are respectively in the Frequency domain and Code domain partitioning.

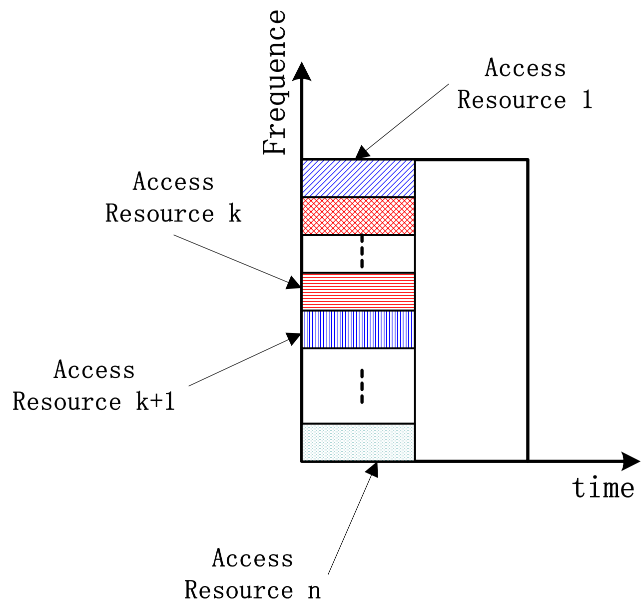

Figure 2 Access resources partitioning in Frequency domain

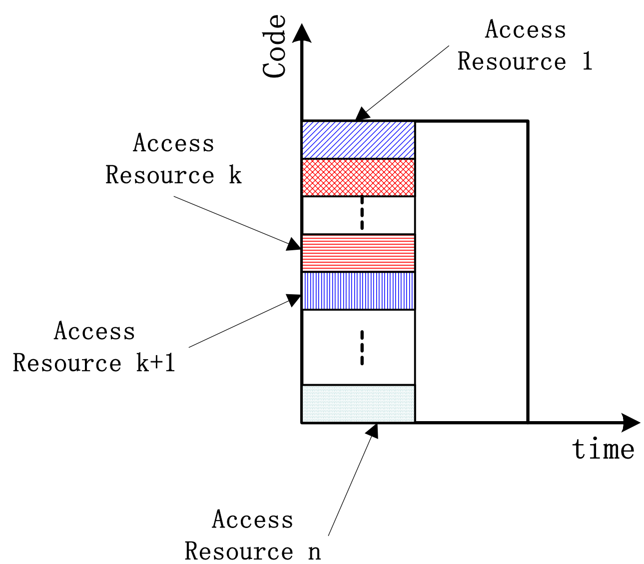

Figure 3 Access resources partitioning in Code domain

The preceding three partitioning mode can be combined randomly to become a new fashion. Figure 4 shows one example of these scenarios.

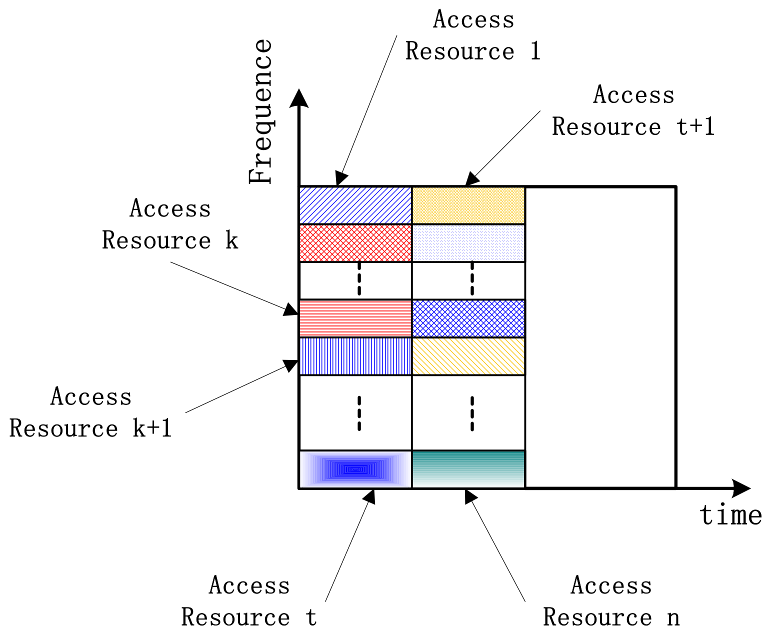

Figure 4 Access resources partitioning in Frequency and Time domain

3. Handoff procedure for MBWA

Terminology

Serving BS: For any MS, the serving BS is the BS with which the MS has recently performed registration at initial network-entry during a handoff.

Target BS: The BS is that a MS intends to be registered with at the end of a handoff.

Neighbor BS: For any MS, a neighbor BS is a BS whose downlink transmission can be demodulated by the MS.

MS: a user that supports mobile functionality.

The handoff process is that a MS migrates from the air-interface provided by one BS to the air-interface provided by another BS. Concretively the handoff process can be divided into two types:

Break-before-Make (BBM): A handoff where service with the target BS starts after a disconnection of service with the serving BS;

Make-before-Break (MBB): A handoff where service with the target BS starts before disconnection of the service with the serving BS.

The objective of handoff is to maintain end-to-end connectivity in the dynamically reconfigured network topology. During a handoff, the route of data through the Serving BS to the Target BS and to the MS must be updated to pass through this Serving BS.

The handoff procedure must be governed by the following principle: Capability to provide consistent end-to-end data loss and delay performance in order to ensure that the handoff delays are minimal with minimum or no packet loss.

The following section contains the procedures performed during the BBM and the MBB handoff on the air-interface.

1.1 Break-before-Make handoff procedure

The BBM type handoff procedure consists of the following stages:

1. The serving BS shall broadcast information about the network topology using the broadcast message, i.e. what are neighbor BSs are. MS may decode this message to find out information about the parameters of neighbor BSs. Each MS will thus be able to synchronous quickly with neighbor BSs later.

2. A MS in the local cell may negotiate with the serving BS to demand a time intervals and cycle for the purpose of seeking and monitoring neighbor BSs suitability as targets for handoff, or the MS decides the time intervals and cycle all alone for measurement based on its PHY capabilities.

3. During the time intervals the MS can listen for radio transmission for any BS “in range” and take signal strength measurement of the transmission. The relative strength radio signals from an MS’s current BS and the next strongest radio source gives the MS an indication of the time when it closes to a new cell.

4. When it finds the signal strength of a certain neighbor BS which is called target BS is stronger than that of serving BS, the MS shall give notice to the serving BS that it is in the overlapping cell coverage area of two adjacent BSs and that it wants to perform the handoff procedure and also the MS shall indicate the recommended target BS to the serving BS.

5. After it receives the message from the MS, the serving BS shall notify the target BS relative information of the handoff request from the MS and about the requesting MS through the backbone network.

6. Receiving the messages from the serving BS, the target BS shall choose one of available access resources allocated for handoff users. Simultaneously the target BS informs the serving BS the access resource and its some other information such as timing and transmission power.

7. Serving BS shall notify the MS who wants to perform handoff the information of access resource, timing and power etc.

8. After the handshake between the serving BS and the MS and between the BSs, the MS may begin the actual BBM handoff, while the serving BS may terminate all connections and discard MAC state machines and the context associated with the MS (i.e. information in queues, ARQ state-machine, counters, timers, etc.).

9. Network re-entry in target BS, where the MS re-enters the network using the access resource designated by the target BS. The MS shall receive relative information of precise timing and power regulation. After network re-entry, connections belonging to the MS are re-established based on the availability of resources in the target BS.

The above stages may be shown visually in Figure 5:

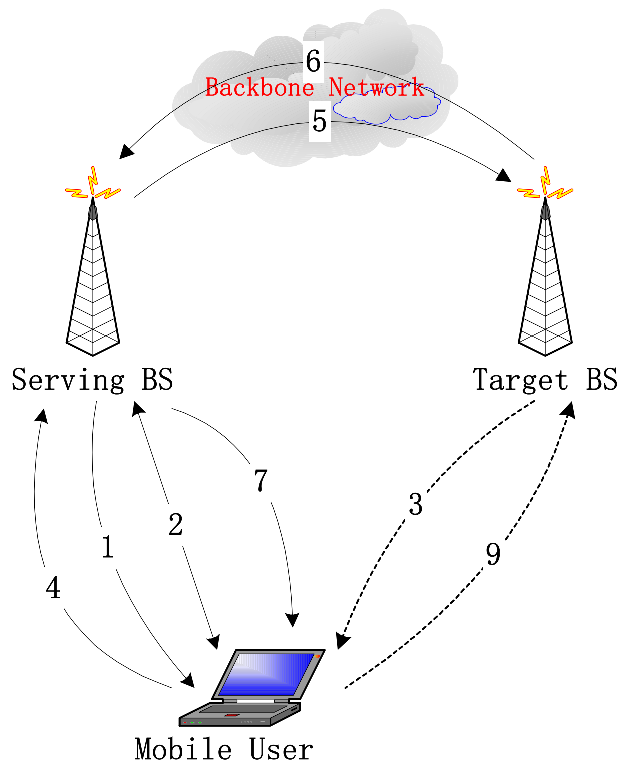

Figure 5 Break-before-Make handoff procedure chart

1.2 Make-before-Break handoff procedure

The MBB type handoff procedure consists of the following steps:

1. The serving BS shall broadcast information about the network topology using the broadcast message, i.e. what are neighbor BSs are. MS may decode this message to find out information about the parameters of neighbor BSs. Each MS will thus be able to synchronous quickly with neighbor BSs later.

2. A MS in the local cell may negotiate with the serving BS to demand a time intervals and cycle for the purpose of seeking and monitoring neighbor BSs suitability as targets for handoff, or the MS decides the time intervals and cycle all alone for measurement based on its PHY capabilities.

3. During the time intervals the MS can listen for radio transmission for any BS "in range" and take signal strength measurement of the transmission. The relative strength radio signals from an MS's current BS and the next strongest radio source gives the MS an indication of the time when it closes to a new cell.

4. When it finds the signal strength of a certain neighbor BS which is called target BS is stronger than that of serving BS, the MS shall give notice to the serving BS that it is in the overlapping cell coverage area of two adjacent BSs and that it wants to perform the handoff procedure and synchronously the MS shall indicate the recommended target BS to the serving BS.

5. After it receives the messages from the MS, the serving BS shall notify the target BS relative information of the handoff request from the MS and about the requesting MS through the backbone network.

6. Receiving the messages from the serving BS, the target BS shall choose one of available access resources allocated for handoff users. Simultaneously the target BS informs the serving BS this access resource and its some other information such as timing and transmission power.

7. Serving BS shall notify the MS who wants to perform handoff the information of access resource, timing and power etc.

8. The MS shall connect with the target BS using the access resource allocated by the target BS in order to regulate the timing and the level of power etc.

9. After acquiring the access information from the MS, the target BS shall notify the MS the regulation information of timing and level of power. At the same time the MS can now learn the care-of address (CoA) from the broadcast information or the access grant message from the target BS. (Please note: Currently the MS maintains its connectivity to its serving BS)

10. At the target BS, the MS can now register its new CoA to its home agent (HA) and in this way redirect traffic to the target BS. During link layer registration, context transfer and Mobile IP registration take place in the target BS, but the MS still has IP connectivity through the serving BS. In this way, the MS does not suffer any delay or packet loss.

11. When the MS's registration request message reaches its home agent, the home agent will begin forwarding packets towards the new CoA of the target BS.

12. The MS eventually closes the link with the serving BS after sufficient time has elapsed to ensure with high probability that no packets remain in flight from the home agent to the serving BS, while the serving BS may terminate all connections

and discard MAC state machines and the context associated with the MS (i.e. information in queues, ARQ state-machine, counters, timers, etc.).

The above steps may be shown visually in Figure 6:

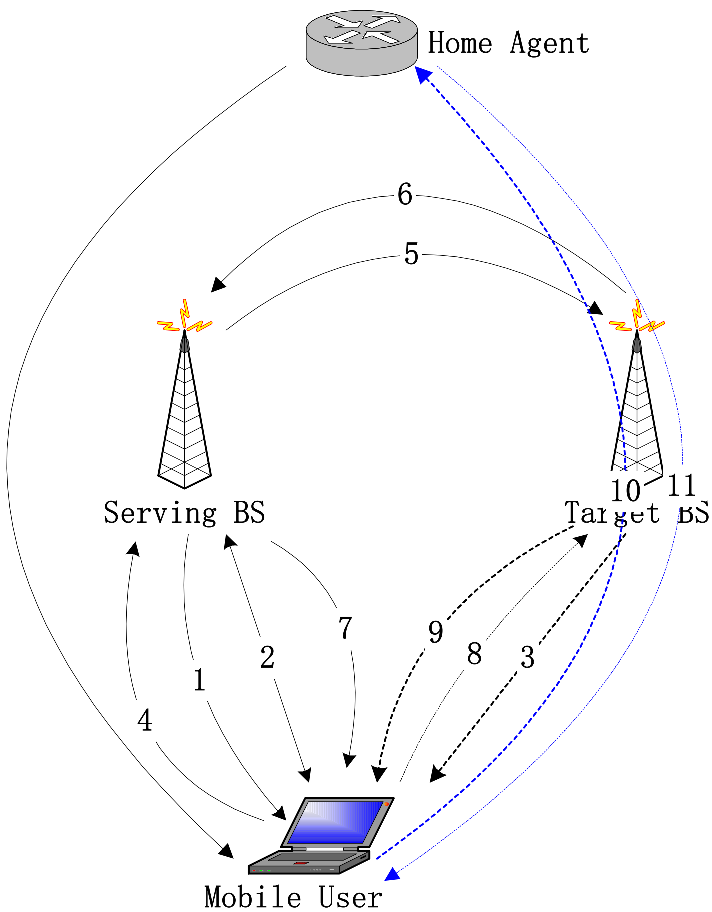

Figure 6 Make-before-break handoff procedure chart

4. Additional procedure for MBWA handoff

To improve the usage efficiency of access resource, the BS shall evaluate the number of the handoff users at the different time of a day for a period of time, and further make a decision of the access resource proportion between those for handoff users from neighboring cell and those for initial access users in the local cell. And the proportion shall be broadcasted termly or aperiodically by the BS in a cell.

If there are no more access resources for handoff users in the target cell, the target BS shall designate an access resource from those for initial user to the handoff users. The reason to the method is that the performance of the handoff users are much important than that of the initial users.

If the handoff user fails to access the target BS, the system shall give him another ‘n-1’ chances to access the cell. Here ‘n’ is a threshold and the maximum times within which it can attempt to access the target BS.

5. Conclusion

In this contribution, the detailed MBWA procedures for both Make-before-Break handoff and Break-before-Make handoff are proposed. This approach has the following main characteristics:

Access resources are divided by Frequency, time, code or combined one or more of them, and the total access resources in a cell shall be separated into two parts: one for the handoff users from the neighboring cells and the other for the initial users in the local cell. And the proportion between the two parts can be changed according to monitoring the change of the number of the handoff users by BS.

In virtue of the characteristics, the handoff delays shall be minimized with minimum or no packet loss. The system performance and the level of user contentment will be improved.