

Enhanced pre-notification procedure for GERAN MBMS**BACKGROUND OF THE INVENTION****RELATED APPLICATIONS**

- 5 This application claims priority from U.S. Provisional Patent Application Serial Number 60/611,140 which was filed on September 17, 2004.

1. Field of the Invention

- 10 The invention is directed to a system and methods for transmitting/receiving data during Broadcast mode and Multicast mode and, more particularly, to a system and method for reducing idle mode power consumption for mobile stations (MS) that have joined a Multimedia Broadcast/Multicast Service (MBMS) session and await the start of the session.

15 **2. Description of the Related Art**

- MBMS (Multimedia Broadcast/Multicast Service) is a unidirectional Point-to-Multipoint (p-t-m) multicast/broadcast service in which data is transmitted from a single source entity to a group of users located in a specific area. MBMS may comprise a selection of unidirectional p-t-m bi-directional point-to-point (p-t-p) transmissions of multimedia data, such as text, audio, picture, or video, from a single source entity to a multiplicity of users in a service area. As stated in the 3rd Generation Partnership Project (3GPP) Technical Specification (TS) 22.146, "Multimedia Broadcast/Multicast Service; Stage 1", it is a goal of MBMS is to allow the provision of multiple instances of a p-t-p service with a single transmission over a radio interface as a radio multicast. "Service area" for a given MBMS service is hereafter to be understood as the geographical area (i.e. set of cells) where the service is made available.

- MBMS has two modes, e.g., Broadcast mode and Multicast mode. The main difference between these two modes is that in Broadcast mode all MBMS users in the service area are targeted for receipt of transmitted data, whereas in Multicast mode it is possible to address only a subset of the MBMS users in the service area

for receipt of the data. As defined in the 3GPP TS 22.146, "Multimedia Broadcast/Multicast Service; Stage 1," Multicast mode typically requires a user to subscribe to a multicast group before receiving the service.

As defined in the 3GPP TS 43.246, "MBMS in the Global System for
5 Mobile communication (GSM) Enhanced Data GSM Environment (EDGE) Radio
Access Network (GERAN); Stage 2", a mobile station (MS) that has joined a paging
group and has requested an MBMS session monitors an MBMS specific paging
group for MBMS notifications. In order to permit the MS to save power by not
reading all messages on the MBMS notification paging group, a single pre-
10 notification bit (i.e., a flag) is sent on the primary paging group of the MS. This flag
indicates that the MS must read the MBMS notification paging group or that the MS
is not required to read the notification paging group. When the MS is not required to
read the MBMS notification paging group, the network is permitted to send, instead
of normal paging messages, other messages on the paging channel. In this case,
15 however, it is not always possible to provide an indication of the status of the pre-
notification flag. As a result, the MS is required to read the MBMS notification
paging group even if a notification at that specific instant in time would not occur.

One problem with the prior art solutions for reducing MS power
consumption, which is discussed in G2-MBMS04002 "Discussion paper: MBMS
20 Pre-notification and Notification", Ericsson 3GPP GERAN2 adhoc on MBMS,
Turin, Italy, is that MBMS mobile stations may easily be required to read all MBMS
specific paging group messages. This will occur if new MBMS sessions start
frequently. Public land mobile network (PLMN) wide MBMS sessions need to be
notified in all cells and location area wide MBMS sessions need to be notified in all
25 cells of a location area. In addition, MBMS sessions intended for smaller areas to
which a specific cell still belongs may exist. Moreover, MBMS sessions may occur
even more frequently outside of busy periods when more network capacity would
become available for downloading and recreational services, for example. In this
case, frequent notifications are more likely to occur throughout any given day. In
30 order to account for and process "lost" pre-notifications, the MS may be required to
continuously read all MBMS specific paging group messages. If the discontinuous
reception (DRX) period for an MBMS session is equal to the basic paging group of

the MS, the power consumption of the MS will be increased by approximately 100%. Typically, the DRX period is used to minimize battery consumption in the MS. The DRX is defined using three parameters, i.e., DRX on/off, DRX period (paging group definition) and non-DRX timer, e.g., how long the MS stays in a non-
5 DRX mode after the last transfer of data.

Another problem associated with the prior art solution for reducing MS power consumption is that MBMS sessions may be notified very frequently in a cell. As a result, an MBMS mobile station would be required to continuously read the MBMS paging group even if the pre-notification flag informs the MS about
10 incoming notification

SUMMARY OF THE INVENTION

The invention is directed to a system and method for reducing idle mode
15 power consumption for mobile stations (MS) that have joined a Multimedia Broadcast/Multicast Service (MBMS) session and are waiting for the session to start. The invention is also directed to reducing the power consumption of an MS for which an MBMS session is inactive. In alternative aspects of the invention, the power consumption of mobile stations is reduced in the absence of ongoing MBMS
20 session activity.

Reduced power consumption is achieved by eliminating the need to read notification messages from an MBMS specific notification paging group when the notification message is for a different MBMS session than the paging group that the MS has currently joined. In accordance with the invention, excessive pages from a
25 MBMS notification paging group to the MS, in addition to the basic paging group, are eliminated. As a result, neighbor cell system information type 3 and type 4 (SI3 and SI4) decoding and cell broadcast channel (CBCH) reception from a serving cell can be performed without conflicting with MBMS tasks.

The system and method of the invention provides the option to eliminate the
30 need to define a specific MBMS notification paging group. Here, the MS is permitted to enter non-DRX mode after a pre-notification is transmitted to the MS, which permits the actual notification to be sent at any paging group. This permits

significant flexibility during load sharing between different paging groups. As a result, extended paging can be avoided, which results in a reduction of the power that is consumed by the MS, even when the MS is not involved in an MBMS session. For example, power consumption is reduced in MSs that are members of an MBMS session and those MBMS MSs that have not joined any MBMS sessions or are not waiting for the broadcast of an MBMS session to begin.

In accordance with the invention, the MS is informed about an upcoming notification via pre-notification information that at least partially identifies the MBMS bearer service which is to be notified. In an embodiment of the invention, if the pre-notification information fully identifies the MBMS bearer service (at least uniquely within a given Public land mobile network (PLMN)), then the identity of the actual MBMS session within the MBMS bearer service to be notified may also be transmitted.

The Temporary Mobile Group Identity (TMGI) is used for MBMS notification purposes. The broadcast/multicast service center (BM-SC) allocates a single globally unique TMGI per MBMS bearer service. Here, the TMGI is comprised of two parts, i.e. a globally unique MCC/MNC identity (e.g. a PLMN ID) and a local MBMS bearer service identity that is unique within the PLMN.

In accordance with the invention, a full TMGI that provides a unique identification of the MBMS Bearer Service across PLMNs is sent to the MS. Preferably, a TMGI excluding the PLMN information is sent. As a result, a unique identification of the MBMS Bearer Service within a given PLMN is provided, and a pre-notification with low or high granularity can be used. Granularity relates to the relative size, scale, level of detail, or depth of penetration that characterizes an object or activity. In accordance with the contemplated embodiments, it is possible to transmit the identity of the MBMS session to be notified, along with the TMGI or the TMGI without the PLMN ID, hence obtaining the highest possible granularity. When the actual session is not indicated at pre-notification, a lower granularity is obtained. An even lower granularity is achieved when only a subset of the TMGI is used (e.g., a TMGI excluding the PLMN ID or a modulo of the TMGI). Given the integers a , b and n , the expression $a \equiv b \pmod{n}$ (i.e., “ a is congruent to b modulo

n”) means that a and b have the same remainder when divided by n, or equivalently, that a-b is a multiple of n.

The system and method of the invention eliminates the need for an MS waiting for MBMS notifications to read an additional paging group where an addressed notification would actually not occur. Moreover, extended paging can be avoided, which reduces power consumption of all mobiles stations monitoring the paging group where extended paging occurs.

Other objects and features of the present invention will become apparent from the following detailed description considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are designed solely for purposes of illustration and not as a definition of the limits of the invention, for which reference should be made to the appended claims. It should be further understood that the drawings are merely intended to conceptually illustrate the structures and procedures described herein.

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BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other advantages and features of the invention will become more apparent from the detailed description of the preferred embodiments of the invention given below with reference to the accompanying drawings in which:

FIG. 1 is an exemplary block diagram of a wireless communication system in which the method of the invention is implemented; and

FIG. 2 is a flow chart illustrating the steps of the method in accordance with the present invention.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

The invention is directed to a system and method for reducing idle mode power consumption for mobile stations (MS) that have joined a Multimedia Broadcast/Multicast Service (MBMS) session and are waiting for the session to start. FIG. 1 shows a simplified block diagram of an embodiment of an exemplary wireless telecommunications system 1 that includes a plurality of mobile terminals or stations 10. Two mobile stations (MSs) 10 are shown, with one being

designated MS#1 and the other MS#2. Although two mobile stations are shown, more than two are preferably used in accordance with the present invention.

FIG. 1 also shows an exemplary network operator 2 having, for example, a mobile switching center (MSC) 3 for connecting to a telecommunications network, such as the Public Switched Telephone Network (PSTN), at least one base station controller (BSC) 4, and a plurality of base transceiver stations (BTS) 5 that transmit in a forward or downlink direction both physical and logical channels to the mobile stations 10 in accordance with a predetermined air interface standard. It is assumed that a reverse or uplink communication path exists from the mobile station 10 to the network operator, which conveys mobile originated access requests and traffic, as well as signaling for implementing the invention. The BTSs 5 define cells, which can be different sizes, different frequencies and so forth.

The air interface standard may conform to a Time Division Multiple Access (TDMA) air interface, and the network may be a Universal Mobile Telecommunications System (UMTS) network or other type of network. However, the teachings of the present invention apply equally to Code Division Multiple Access (CDMA) networks, as well as to other network types.

The network operator 2 can include a Message Service Center (MSCT) 6 that receives and forwards messages for the MS 10, such as Short Message Service (SMS) messages, or any wireless messaging technique including e-mail and Supplementary Data Services. Furthermore, enhancements to SMS can be used, such as one under development and known as Multimedia Messaging Service (MMS), wherein image messages, video messages, audio messages, text messages, executables and the like, and combinations thereof, can be transferred between a network and a mobile station.

The mobile station (MS) 10 typically includes a micro-control unit (MCU) 12 having an output coupled to an input of a display 14 and an input coupled to an output of a keyboard or keypad 16. The MS 10 may be considered to be a handheld radiotelephone, such as a cellular, mobile telephone or a personal digital assistant (PDA), and may have a microphone and a speaker (not shown) for conducting voice communications. The MS 10 could also be contained within a card or module that is connected during use to another device. For example, the MS 10 could be contained

within a PCMCIA or similar type of card or module that is installed during use within a portable data processor, such as a laptop or notebook computer, or even a computer that is wearable by the user.

The MCU 12 is assumed to include or be coupled to some type of a memory 13, including a read-only memory (ROM) for storing an operating program, as well as a random access memory (RAM) for temporarily storing required data, scratchpad memory, received data packets and data packets prepared for transmission, etc. The memory 13 is assumed to store the various parameters which are used by the MS 10 for performing cell reselection.

A separate, removable SIM (not shown) can be also be provided, the SIM storing, for example, a preferred Public Land Mobile Network (PLMN) list and other subscriber-related information. The ROM is assumed, for the purposes of this invention, to store a program enabling the MCU 12 to execute the software routines required to operate in accordance with the presently preferred embodiments of the present invention.

The MS 10 also contains a wireless section that includes a digital signal processor (DSP) 18, or equivalent high speed processor, as well as a wireless transceiver comprised of a transmitter 20 and a receiver 22, both of which are coupled to an antenna 24 for communication with the network operator 2. The receiver 22 is used for making signal measurements used in the cell reselection process.

In accordance with the invention, the MS 10 is informed about an upcoming notification via pre-notification information that at least partially identifies the MBMS bearer service which is to be notified. In an embodiment of the invention, if the pre-notification information fully identifies the MBMS bearer service (at least uniquely within a given public land mobile network (PLMN)), then the identity of the actual MBMS session within the MBMS bearer service to be notified may also be transmitted.

As defined in 3GPP TS 23.246, "Multimedia Broadcast/Multicast Service (MBMS); Architecture and functional description", the Temporary Mobile Group Identity (TMGI) is used for MBMS notification purposes. The broadcast/multicast service (BM-SC) allocates a single globally unique TMGI per MBMS bearer

service. Here, the TMGI is comprised of two parts, i.e. a globally unique MCC/MNC identity (e.g. a PLMN ID) and a local MBMS bearer service identity that is unique within the PLMN. On the one hand, the TMGI will be transmitted to user equipment (UE) via a service activation procedure for multicast MBMS bearer services. On the other hand, the TMGI can be obtained via a service announcement, as described in TS 23.246 (see, e.g., "Service Announcement" for broadcast service). In this case, the TMGI is a radio resource efficient MBMS bearer service identifier that is equivalent to the MBMS bearer service identification consisting of IP multicast address and access point node.

10 In accordance with the invention, a full TMGI that provides a unique identification of the MBMS bearer service across PLMNs is sent to each MS 10. Preferably, a TMGI that excludes the PLMN information is sent. As a result, a unique identification of the MBMS bearer service within a given PLMN is provided. This permits a pre-notification with higher granularity to be achieved. Granularity
15 relates to the relative size, scale, level of detail, or depth of penetration that characterizes an object or activity. In accordance with the contemplated embodiments, it is possible to transmit the identity of the MBMS session to be notified to each MS 10, along with the TMGI or the TMGI without the PLMN ID.

If the network attempts to page a large number of mobile stations, then a
20 lower number of bits are used for the pre-notification information. Here, a parameter having a short bit length that is defined as a function of the TMGI may be used to provide the pre-notification to each MS 10. Preferably, this parameter is a modulo of a variable portion of the TMGI. However, it is also possible to use any predefined function of the TMGI. Given the integers a , b and n , the expression $a \equiv b$
25 (mod n) (i.e., "a is congruent to b modulo n") means that a and b have the same remainder when divided by n , or equivalently, that $a-b$ is a multiple of n .

Performing pre-notifications via the TMGI with or without a PLMN ID permits a specific MS 10 to fully identify whether the incoming pre-notification information addresses the specific MS 10. If the incoming pre-notification
30 information does not address the specific MS 10, then the MS 10 would not be required to read any additional messages. As a result, extra power consumption is not caused by the MBMS pre-notifications.

Pre-notifications accurately address the actual MBMS session that is in progress. As a result, it is possible to activate non-DRX mode after each pre-notification is matched with its relevant MS 10. In turn, activation of non-DRX mode after each pre-notification permits the actual notification to be sent on any paging group, or even on blocks reserved for only granting an MS 10 with access to an MBMS session.

In accordance with the invention, each MS 10 is no longer required to read more than the normal paging group, when no notifications are addressed to the MS. As a result, the likelihood for conflicts to occur when reading non-addressed notifications that are not addressed to the MS and cell broadcast channels, neighbor cell system information type 3 and type 4 (i.e., SI3/SI4 on a common control channels (CCCH) cell) is eliminated. In the worst case, it should be noted that the mobile station may be required to continuously read two paging groups (e.g., the normal paging group and the MBMS specific notification paging group). In this case, it then becomes impossible to read CBCH or neighbor cell system information for some DRX cycles.

FIG. 2 is a flow chart illustrating the steps of the method in accordance with the present invention. An MBMS specific paging group is monitored to detect MBMS notifications, as indicated in step 200. Here, the paging group is monitored by a MS that has requested to join an MBMS session.

Next, MBMS pre-notification information is transmitted within an MBMS pre-notification message to the MS that made the request to join the MBMS session, as indicated in step 210. The pre-notification information is a unique Temporary Mobile Group Identity (TMGI) which is allocated by the broadcast/multicast service for each MBMS bearer service. The TMGI is comprised of two parts, i.e. a globally unique MCC/MNC identity (e.g. a PLMN ID) and a local MBMS bearer service identity that is unique within the PLMN. Preferably, a TMGI that excludes the PLMN information is sent. As a result, a unique identification of the MBMS bearer service within a given PLMN is provided.

A check of the pre-notification information in the MBMS notification message is then performed to acquire the TMGI, as indicated in step 220. The TMGI is then checked to determine whether it corresponds to the MBMS bearer

service for the PLMN, as indicated in step 230. If the TMGI corresponds to the MBMS bearer service for a joined MBMS session, then the MS continues to read additional messages, as indicated in step 250. If the TMGI does not correspond to the MBMS bearer service for a PLMN, then the MS terminates the reading of any
5 further messages to conserve power, as indicated in step 250.

Using the system and method of the invention, a mobile station waiting for MBMS notifications would never, or at most very rarely, be required to read an additional paging group where an addressed notification would actually not occur. Moreover, extended paging can be avoided, which reduces power consumption of all
10 mobiles stations monitoring the paging group where extended paging occurs.

Thus, while there have shown and described and pointed out fundamental novel features of the invention as applied to a preferred embodiment thereof, it will be understood that various omissions and substitutions and changes in the form and details of the devices illustrated, and in their operation, may be made by those
15 skilled in the art without departing from the spirit of the invention. For example, it is expressly intended that all combinations of those elements and/or method steps which perform substantially the same function in substantially the same way to achieve the same results are within the scope of the invention. Moreover, it should be recognized that structures and/or elements and/or method steps shown and/or
20 described in connection with any disclosed form or embodiment of the invention may be incorporated in any other disclosed or described or suggested form or embodiment as a general matter of design choice. It is the intention, therefore, to be limited only as indicated by the scope of the claims appended hereto.

CLAIMS

1. A method for informing mobile stations (MS) that have joined a Multimedia Broadcast/Multicast Service (MBMS) session and are waiting for data associated with incoming data for the service, comprising the steps of:

5 monitoring a paging group with the MS to detect MBMS pre-notifications;

 transmitting MBMS pre-notification information within an MBMS notification message on the paging group to MSs on the paging group;

10 checking the pre-notification information in the MBMS notification message to acquire a Temporary Mobile Group Identity (TMGI);

 determining whether the TMGI corresponds to the MBMS bearer service for a joined MBMS session; and

15 reading additional messages if the TMGI corresponds to the MBMS bearer service for a public land mobile network (PLMN).

2. The method of claim 1, further comprising the step of:

20 terminating the reading of messages if the TMGI does not correspond to the MBMS bearer service for the PLMN to conserve power.

3. The method of claim 1, wherein the paging group is monitored by the MS that has requested to join the MBMS session.

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4. The method of claim 1, wherein the pre-notification information is a Temporary Mobile Group Identity (TMGI) which is allocated by a broadcast/multicast service for each MBMS bearer service.

30 5. The method of claim 2, wherein the TMGI comprises a PLMN ID and a local MBMS bearer service identity that is unique within the PLMN.

6. The method of claim 4, wherein the TMGI is sent to the MSs without PLMN ID information.

5 7. The method of claim 5, wherein TMGI is sent to the MSs without the PLMN ID.

8. The method of claim 1, wherein the paging group is an MBMS specific paging group.

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9. A system for informing mobile stations (MS) that have joined a Multimedia Broadcast/Multicast Service (MBMS) session and are waiting for data associated with incoming data for the session, comprising:

15 means for monitoring a paging group to detect MBMS pre-notifications;

 means for transmitting MBMS pre-notification information within an MBMS notification message on the paging group to MSs on the paging group;

20 means for checking the pre-notification information in the MBMS notification message to acquire a Temporary Mobile Group Identity (TMGI);

 means for determining whether the TMGI corresponds to an MBMS bearer service for a joined MBMS session; and

25 means for reading additional messages if the TMGI corresponds to the MBMS bearer service for a public land mobile network (PLMN).

10. The system of claim 9, wherein reading of messages is terminated if the TMGI does not correspond to the MBMS bearer service for the PLMN to conserve power.

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11. The system of claim 9, wherein the paging group is monitored by the MS that has requested to join the MBMS session.

12. The system of claim 9, wherein the pre-notification information is a Temporary Mobile Group Identity (TMGI) which is allocated by a broadcast/multicast service for each MBMS bearer service.

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13. The system of claim 10, wherein the TMGI comprises a PLMN ID and a local MBMS bearer service identity that is unique within the PLMN.

14. The system of claim 12, wherein the TMGI is sent to the MSs without PLMN ID information.

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15. The method of claim 13, wherein TMGI is sent to the MSs without the PLMN ID.

16. The system of claim 9, wherein the paging group is an MBMS specific paging group.

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17. A computer program product for use in a system for mobile stations comprising a computer usable medium having computer readable program code thereon, the computer readable program code including:

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program code for monitoring a paging group to detect MBMS notifications;

program code for transmitting MBMS pre-notification information within an MBMS notification message on the paging group to MSs on the paging group;

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program code for checking the pre-notification information in the MBMS notification message to acquire a Temporary Mobile Group Identity (TMGI);

program code for determining whether the TMGI corresponds to an MBMS bearer service for the joined MBMS session; and

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program code for reading additional messages if the TMGI corresponds to the MBMS bearer service for a public land mobile network (PLMN).

18. A mobile station, comprising:

a processing unit;

a memory connected to the processing unit;

5 a display connected to the processing unit;

a plurality of internal features, each feature providing a unique functionality application, said plurality of internal features being located in hardware, firmware and/or an operating system of the mobile station; and

10 a cellular transceiver connected to the processing unit and adapted to communicate with a controller located at a remote location;

wherein said mobile station is configured to monitor a paging group to detect MBMS pre-notifications, receive MBMS pre-notification information within an
15 MBMS notification messages, check the pre-notification information in the MBMS notification message to acquire a Temporary Mobile Group Identity (TMGI), and determine whether the TMGI corresponds to an MBMS bearer service for a public land mobile network (PLMN).

20 19. The mobile station of claim 18, wherein reading of messages is terminated if the TMGI does not correspond to the MBMS bearer service for the PLMN to conserve power.

20 20. The mobile station of claim 18, wherein the pre-notification information is a Temporary Mobile Group Identity (TMGI) which is allocated by a broadcast/multicast service for each MBMS bearer service.

21. The mobile station of claim 18, wherein the TMGI comprises a PLMN ID and a local MBMS bearer service identity that is unique within the PLMN.

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22. The method of claim 18 wherein the paging group is an MBMS specific paging group.

23. A base transceiver station for informing mobile stations (MS) that have joined a Multimedia Broadcast/Multicast Service (MBMS) session and are waiting for data associated with incoming data for the service, comprising:

5 means for determining whether an MS has requested to join the MBMS session;

 means for transmitting MBMS pre-notification information within an MBMS notification message to the MS requesting to join the MBMS session;

10 means for checking the pre-notification information in the MBMS notification message to acquire a Temporary Mobile Group Identity (TMGI);

 means for determining whether the TMGI corresponds to an MBMS bearer service for the requested MBMS session; and

15 means for receiving additional messages if the TMGI corresponds to the MBMS bearer service for a public land mobile network (PLMN).

24. The base transceiver station of claim 23, wherein reading of messages is terminated if the TMGI does not correspond to the MBMS bearer service for the
20 PLMN to conserve power.

25. The base transceiver station of claim 23, wherein a paging group is monitored by the MS that has requested to join the MBMS session.

25 26. The base transceiver station of claim 23, wherein the pre-notification information is a Temporary Mobile Group Identity (TMGI) which is allocated by a broadcast/multicast service for each MBMS bearer service.

27. The base transceiver station of claim 24, wherein the TMGI comprises a
30 PLMN ID and a local MBMS bearer service identity that is unique within the PLMN.

28. The base transceiver station of claim 27, wherein the TMGI is sent to MSs without PLMN ID information.

29. The base transceiver station of claim 27, wherein the TMGI is sent to
5 MSs without the PLMN ID.

30. The base transceiver station of claim 23, wherein the paging group is an MBMS specific paging group.