

DESCRIPTION

PAGING SIGNAL TRANSMISSION METHOD, MOBILE STATION AND RADIO
BASE STATION

5 TECHNICAL FIELD

[0001]

The present invention relates to a paging signal
transmission method in which a radio base station transmits a
paging signal for notification of an incoming call for a mobile
10 station belonging to any one of multiple groups, and also
relates to the mobile station and the radio base station.

BACKGROUND ART

[0002]

15 With reference to Fig. 7, description will be given of
how a radio base station eNB in a mobile communication system
of the LTE (Long Term Evolution) system operates to transmit
a paging signal for notification of an incoming call for a mobile
station UE belonging to any one of multiple groups #1 to #3 (that
20 is, a paging signal transmission method).

[0003]

As shown in Fig. 7, the radio base station eNB is
configured to transmit a PDCCH (Physical Downlink Control
Channel) including a P-RNTI (Paging-Radio Network Temporary
25 Identifier), in a subframe for the group #1 (in the example in
Fig. 7, a subframe #0 in a radio frame #0), upon detection of
an incoming call for the mobile station UE belonging to the group
#1.

[0004]



G00002



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Note that, the radio base station eNB is configured to use the PDCCH to notify, to the mobile station UE belonging to the group #1, the resource block position, the resource block size, and the like of a PDSCH (Physical Downlink Shared Channel) to which a PCH (Paging Channel) for the group #1 (i.e., a paging signal for notification of an incoming call for a mobile station UE belonging to the group #1) is mapped.

[0005]

Moreover, the radio base station eNB is configured to use the PDSCH to make notification of identification information (UE-ID) on the mobile station UE which is to receive the above-described incoming call.

[0006]

Meanwhile, the mobile station UE is configured to monitor whether or not the PDCCH including the P-RNTI is transmitted, at discontinuous reception intervals (paging DRX intervals) for the group #1.

[0007]

The mobile station UE is configured to receive the PDSCH corresponding to the PDCCH, on the basis of information included in the PDCCH (e.g., the resource block position, the resource block size, and the like of the PDSCH), when judging that the PDCCH including the P-RNTI has been transmitted.

[0008]

The mobile station UE is also configured to perform incoming call processing with the radio base station eNB, when the UE-ID included in the received PDSCH is a UE-ID addressed to itself.

Non-patent Literature 1: 3GPP TS36.300, "E-UTRA and E-UTRAN;
Overall description; Stage 2", v8.1.0.

Non-patent Literature 2: R2-073372, "Paging Procedure in LTE",
NTT DoCoMo, Inc., NEC.

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[0009]

However, with a conventional paging transmission method
implementable in the mobile communication system of the LTE
system, only one subframe (1 ms) is allowed to be set in each
10 radio frame (10 ms) and used to transmit the PCH (paging signal)
for each group.

[0010]

Thus, such mobile communication system has a problem that
the PCH may not possibly be mapped to the subframe in a case
15 where the cell bandwidth is narrow, another signal (e.g., BCCH:
Broadcast Control Channel or the like) is mapped to the subframe,
or some other cases.

DISCLOSURE OF THE INVENTION

20 [0011]

The present invention has been made in view of the above
problem, and thus has an object to provide a paging signal
transmission method, a mobile station, and a radio base station
which allow a flexible change in the timing for transmitting
25 a paging signal for each group.

[0012]

A first aspect of the present invention is summarized as
a paging signal transmission method in which a radio base
station transmits a paging signal for notification of an

incoming call for a mobile station belonging to any one of a plurality of groups, the method including the steps of: notifying, from the radio base station to the mobile station, a discontinuous reception interval and a total number of the groups, the discontinuous reception interval representing an interval at which discontinuous reception of the paging signal is performed; determining, at the mobile station, a timing for receiving the paging signal on the basis of the notified discontinuous reception interval and the notified total number of the groups; receiving, at the mobile station, the paging signal transmitted from the radio base station, at the determined timing; and performing, at the mobile station, incoming call processing, when the received paging signal is a paging signal addressed to the mobile station.

15 [0013]

A second aspect of the present invention is summarized as a mobile station configured to receive a paging signal from a radio base station, the paging signal being used for notification of an incoming call for a mobile station belonging to any one of a plurality of groups, the mobile station including: a reception timing determining unit configured to determine a timing for receiving the paging signal, on the basis of an discontinuous reception interval and a total number of the groups notified by the radio base station, the discontinuous reception timing representing an interval at which discontinuous reception of the paging signal is performed; a paging signal receiver unit configured to receive the paging signal transmitted from the radio base station, at the timing determined by the reception timing determining unit; and an

incoming call processor unit configured to perform incoming call processing, when the received paging signal is a paging signal addressed to the mobile station.

[0014]

5 In the second aspect, the reception timing determining unit can be configured to determine that the timing is a subframe which is selected from among a plurality of subframes forming a radio frame to which the paging signal is mapped; and the paging signal can be transmitted only in one subframe in a plurality
10 of radio frames.

[0015]

 In the second aspect, the reception timing determining unit can be configured to determine that the timing is subframes which are selected from among a plurality of subframes forming
15 a radio frame to which the paging signal is mapped; and the paging signal can be transmitted in two or more subframes in one radio frame.

[0016]/[0017]

 In the second aspect, the reception timing determining
20 unit can be configured to determine that the timing is a predetermined subframe in radio frames specified by SFN calculated from the following formula:

[Formula 3]

$$G = U \bmod N$$

$$SFN \bmod T = G \cdot \frac{T}{N}$$

25 where "T" represents the number of the radio frames included in the discontinuous reception interval, "N" represents the total number of the groups, "U" represents

identification information on the mobile station, "G" represents identification information on the group to which the mobile station belongs, and "T ≥ N" is satisfied.

[0018]/[0019]

- 5 In the second aspect, the reception timing determining unit can be configured to determine that the timing is subframes corresponding to SUBFN in each of radio frames specified by SFN calculated from the following formula:

[Formula 4]

$$G = U \bmod N$$

$$SFN \bmod T = \left\lfloor \frac{G}{N} \cdot T \right\rfloor$$

$$SUBFN = G \bmod \left(\frac{T}{N} \right)$$

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where "T" represents the number of the radio frames included in the discontinuous reception interval, "N" represents the total number of the groups, "U" represents identification information on the mobile station, "G" represents identification information on the group to which the mobile station belongs, and "T < N" is satisfied.

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[0020]

- In the second aspect, the reception timing determining unit can be configured to determine the two or more subframes used to transmit the paging signal in the one radio frame, on the basis of an offset from a head subframe in the one radio frame, the offset being notified of by the radio base station.

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[0021]

- In the second aspect, the reception timing determining unit can be configured to determine the two or more subframes used to transmit the paging signal in the one radio frame, on

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the basis of a bitmap indicating the two or more subframes to which the paging signal is mapped, the bitmap being notified of by the radio base station.

[0022]

5 In the second aspect, the reception timing determining unit can be configured to determine the two or more subframes in the one radio frame, on the basis of a mapping pattern indicating a pattern of the two or more subframes to which the paging signal is mapped, the mapping pattern being notified of
10 by the radio base station.

[0023]

A third aspect of the present invention is summarized as a radio base station configured to transmit a paging signal for notification of an incoming call for a mobile station belonging
15 to any one of a plurality of groups, the radio base station including: a paging signal transmitter unit configured to transmit the paging signal only in one subframe in a plurality of radio frames; and a notifier unit configured to notify, to the mobile station, an discontinuous reception interval and a
20 total number of the groups, the discontinuous reception interval representing an interval at which discontinuous reception of the paging signal is performed, wherein a timing for the mobile station to receive the paging signal is determined based on the discontinuous reception interval and
25 the total number of the groups.

[0024]

A fourth aspect of the present invention is summarized as a radio base station configured to transmit a paging signal for notification of an incoming call for a mobile station

belonging to any one of a plurality of groups, the radio base station including: a paging signal transmitter unit configured to transmit the paging signal in two or more subframes in one radio frame; a notifier unit configured to notify, to the mobile station, an discontinuous reception interval and a total number of the groups, the discontinuous reception interval representing an interval at which discontinuous reception of the paging signal is performed; and an adjuster unit configured to adjust the discontinuous reception interval and the total number of the groups, in accordance with the two or more subframes in which the paging signal is transmitted, wherein a timing for the mobile station to receive the paging signal is determined based on the discontinuous reception interval and the total number of the groups.

15 [0025]

In the third or fourth aspect, the adjuster unit can be configured to adjust the discontinuous reception interval and the total number of the groups, in accordance with an amount of incoming call for each mobile station.

20 [0026]

In the third or fourth aspect, the adjuster unit can be configured to adjust the discontinuous reception interval and the total number of the groups, in accordance with an available bandwidth in each cell.

25 [0027]

In the third or fourth aspect, the adjuster unit can be configured to adjust the discontinuous reception interval and the total number of the groups, in accordance with a frequency of change in broadcast information in each cell.

[0028]

In the fourth aspect, the radio frames can be each formed of 10 subframes; broadcast information can be transmitted in the first subframe in each radio frame; and the paging signal transmitter unit can be configured to preferentially use the tenth subframe and the fifth subframe in each radio frame in this order, as subframes in which the paging signal is transmitted.

[0029]

10 In the fourth aspect, the radio frames can be each formed of 10 subframes; broadcast information can be transmitted in the first subframe in each radio frame; and the reception timing determining unit can be configured to determine the tenth subframe in each radio frame as the predetermined timing.

15 [0030]

A fifth aspect of the present invention is summarized as a paging signal transmission method in which a radio base station transmits a paging signal for notification of an incoming call for a mobile station belonging to any one of a plurality of groups, the method including the steps of: notifying, from the radio base station to the mobile station, an discontinuous reception interval and a mapping pattern, the discontinuous reception interval representing an interval at which discontinuous reception of the paging signal is performed, the mapping pattern indicating a pattern of a plurality of subframes to which the paging signal is mapped; determining, at the mobile station, a timing for receiving the paging signal, on the basis of the notified discontinuous reception interval and the notified mapping pattern; receiving, at the mobile

station, the paging signal transmitted from the radio base station, at the determined timing; and performing, at the mobile station, incoming call processing, when the received paging signal is a paging signal addressed to the mobile station.

5 [0031]

A sixth aspect of the present invention is summarized as a mobile station configured to receive a paging signal from a radio base station, the paging signal being used for notification of an incoming call for a mobile station belonging
10 to any one of a plurality of groups, the mobile station including: a reception timing determining unit configured to determine a timing for receiving the paging signal, on the basis of an discontinuous reception interval and a mapping pattern notified by the radio base station, the discontinuous reception
15 timing representing an interval at which discontinuous reception of the paging signal is performed, the mapping pattern being notified of by the radio base station and indicating a pattern of a plurality of subframes to which the paging signal is mapped; a paging signal receiver unit configured to receive
20 the paging signal transmitted from the radio base station, at the timing determined by the reception timing determining unit; and an incoming call processor unit configured to perform incoming call processing, when the received paging signal is a paging signal addressed to the mobile station.

25 [0032]

In the sixth aspect, the reception timing determining unit can be configured to determine that the timing is a subframe which is selected from among a plurality of subframes forming a radio frame to which the paging signal is mapped; and the paging

signal can be transmitted only in one subframe in a plurality of radio frames.

[0033]

5 In the sixth aspect, the reception timing determining unit can be configured to determine that the timing is subframes which are selected from among a plurality of subframes forming a radio frame to which the paging signal is mapped; and the paging signal can be transmitted in two or more subframes in one radio frame.

10 [0034]

In the sixth aspect, the reception timing determining unit can be configured to determine that the timing is subframes corresponding to SUBFN in each of radio frames specified by SFN calculated from the following formula:

15 [Formula 4A]

$$SFN \bmod T = \left\lfloor \frac{T}{N} \cdot (U \bmod N) \right\rfloor$$

$$SUBFN = U \bmod \left\lfloor \frac{N}{T} \right\rfloor$$

where "T" represents the number of the radio frames included in the discontinuous reception interval, "N" represents the total number of the groups, and "U" represents
20 identification information on the mobile station.

[0035]

A seventh aspect of the present invention is summarized as a radio base station configured to transmit a paging signal for notification of an incoming call for a mobile station
25 belonging to any one of a plurality of groups, the radio base station including: a paging signal transmitter unit configured to transmit the paging signal only in one subframe in a plurality

of radio frames; and a notifier unit configured to notify, to the mobile station, an discontinuous reception interval and a mapping pattern, the discontinuous reception interval representing an interval at which discontinuous reception of the paging signal is performed, the mapping pattern indicating a pattern of a plurality of subframes to which the paging signal is mapped, wherein a timing for the mobile station to receive the paging signal is determined based on the discontinuous reception interval and the mapping pattern.

10 [0036]

A eighth aspect of the present invention is summarized as a radio base station configured to transmit a paging signal for notification of an incoming call for a mobile station belonging to any one of a plurality of groups, the radio base station including: a paging signal transmitter unit configured to transmit the paging signal in two or more subframes in one radio frame; a notifier unit configured to notify the mobile station of an discontinuous reception interval and a mapping pattern, the discontinuous reception interval representing an interval at which discontinuous reception of the paging signal is performed, the mapping pattern indicating a pattern of a plurality of subframes to which the paging signal is mapped; and an adjuster unit configured to adjust the discontinuous reception interval and the mapping pattern, in accordance with the two or more subframes in which the paging signal is transmitted, wherein a timing for the mobile station to receive the paging signal is determined based on the discontinuous reception interval and the mapping pattern.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037]

[Fig. 1] Fig. 1 shows a configuration diagram of an entire mobile communication system according to a first embodiment of the present invention.

[Fig. 2] Fig. 2 shows a functional block diagram of a radio base station according to the first embodiment of the present invention.

[Fig. 3] Fig. 3 shows diagrams each for explaining the timing for transmitting a PCH in the mobile communication system according to the first embodiment of the present invention.

[Fig. 4] Fig. 4 shows a functional block diagram of a mobile station according to the first embodiment of the present invention.

[Fig. 5] Fig. 5 shows diagrams each for explaining the timing for transmitting a PCH in the mobile communication system according to the first embodiment of the present invention.

[Fig. 6] Fig. 6 shows a flowchart illustrating operation of the mobile station according to the first embodiment of the present invention.

[Fig. 7] Fig. 7 shows a diagram for explaining operation of the mobile station to determine the timing for receiving a paging signal according to Alternative Embodiment 1 of the present invention.

[Fig. 8] Fig. 8 shows a diagram for explaining operation of the mobile station to determine the timing for receiving a paging signal according to Alternative Embodiment 2 of the present invention.

[Fig. 9] Fig. 9 shows a diagram for explaining operation of the

mobile station to determine the timing for receiving a paging signal according to Alternative Embodiment 3 of the present invention.

[Fig. 10] Fig. 10 shows a table for explaining operation of the mobile station to determine the timing for receiving a paging signal according to Alternative Embodiment 4 of the present invention.

[Fig. 11] Fig. 11 shows a diagram for explaining PCH transmission timings in a conventional mobile communication system.

BEST MODES FOR CARRYING OUT THE INVENTION

[0038]

(Configuration of Mobile Communication System according to First Embodiment of Present Invention)

With reference to Figs. 1 to 5, the configuration of a mobile communication system according to a first embodiment of the present invention will be described. Note that although this embodiment will be described using a mobile communication system of the LTE system as an example, the present invention is not limited to such example, and can be applied to any other mobile communication systems.

[0039]

As shown in Fig. 1, the mobile communication system according to the first embodiment of the present invention is configured such that a radio base station eNB transmits paging signals (PCHs) for notification of incoming calls for mobile stations UE#1 to UE#3 each belonging to any one of multiple groups #1 to #3.

[0040]

Specifically, as shown in Fig. 1, the mobile station UE#1 belonging to the group #1 is configured to receive a PCH (paging signal) for notification of an incoming call for a mobile station UE belonging to the group #1, through a PDCCH#1 and a PDSCH#1 transmitted by the radio base station eNB.

[0041]

Here, a setting is made so that paging DRX interval for all the mobile stations UE belonging to the group #1 would correspond to the timing (subframe unit) for transmitting the PCH for the group #1.

[0042]

Note that, the paging DRX interval represents a discontinuous reception interval indicating an interval at which to perform discontinuous reception of the PCH (paging signal) notified of by the radio base station eNB.

[0043]

The mobile station UE#2 belonging to the group #2 is also configured to receive a PCH (paging signal) for notification of an incoming call for a mobile station UE belonging to the group #2, through a PDCCH#2 and a PDSCH#2 transmitted by the radio base station eNB.

[0044]

Here, a setting is made so that paging DRX interval for all the mobile stations UE belonging to the group #2 would correspond to the timing (subframe unit) for transmitting the PCH for the group #2.

[0045]

The mobile station UE#3 belonging to the group #3 is also

configured to receive a PCH (paging signal) for notification of an incoming call for a mobile station UE belonging to the group #3, through a PDCCH#3 and a PDSCH#3 transmitted by the radio base station eNB.

5 [0046]

Here, a setting is made so that paging DRX intervals for all the mobile stations UE belonging to the group #3 would correspond to the timing (subframe unit) for transmitting the PCH for the group #3.

10 [0047]

The radio base station eNB is configured to broadcast a BCCH to all the mobile stations UE#1 to UE#3 by using predetermined resource blocks through BCHs (Broadcast Channels) or the PDSCHs.

15 [0048]

As shown in Fig. 2, the radio base station eNB includes an incoming call processor unit 11, a PCH transmitter unit 12, a BCCH transmitter unit 13, a cell bandwidth manager unit 14, and a parameter adjuster unit 15.

20 [0049]

The incoming call processor unit 11 is configured to monitor the presence or absence of incoming calls for the mobile stations UE#1 to UE#3 each belonging to any one of the multiple groups #1 to #3.

25 [0050]

The incoming call processor unit 11 is also configured to forward incoming-call information to the mobile stations UE#1 to UE#3, upon receipt of response signals to the PCHs from the mobile stations UE#1 to UE#3, respectively.

[0051]

The PCH transmitter unit 12 is configured to transmit the PCHs (paging signals) to the mobile stations UE#1 to UE#3, each of which belongs to any one of the multiple groups #1 to #3, upon detection of incoming calls for the mobile stations UE#1 to UE#3, respectively, the PCHs being used for notification of the incoming calls, respectively.

[0052]

Specifically, the PCH transmitter unit 12 is configured to determine the way to map each of the PCHs to a subframe.

[0053]

For example, as shown in Fig. 3(a), the PCH transmitter unit 12 may be configured to transmit a PCH (paging signal) in multiple subframes (subframes #0 and #1) in one radio frame (a radio frame #0 or #1).

[0054]

Alternatively, as shown in Fig. 3(b), the PCH transmitter unit 12 may be configured to transmit a PCH (paging signal) only in one subframe (a subframe #0 in a radio frame #0) in any one of multiple radio frames (radio frames #0 and #1).

[0055]

Meanwhile, the PCH transmitter unit 12 may be configured to change the way to map each PCH to a subframe, depending on the amount of incoming call for the corresponding mobile station UE.

[0056]

The PCH transmitter unit 12 may also be configured to change the way to map each PCH to a subframe, depending on the available bandwidth in the corresponding cell.

[0057]

The PCH transmitter unit 12 may also be configured to change the way to map each PCH to a subframe, depending on the frequency of change in the BCCH (broadcast information) in the
5 corresponding cell.

[0058]

The BCCH transmitter unit 13 is configured to notify, to each of the mobile stations UE#1 to UE#3, the corresponding paging DRX interval (discontinuous reception interval) and the
10 total number of groups through the BCCH.

[0059]

For example, as the paging DRX interval, the BCCH transmitter unit 13 may transmit identification information which defines the paging DRX interval, or alternatively,
15 transmit the number of radio frames included in the paging DRX interval.

[0060]

Meanwhile, the BCCH transmitter unit 13 may be configured to notify, to each of the mobile stations UE#1 to UE#3, a
20 corresponding subframe offset M, bitmap, or mapping pattern to be described later, through the BCCH.

[0061]

The cell bandwidth manager unit 14 is configured to manage the available bandwidth in each cell.

25 [0062]

The parameter adjuster unit 15 is configured to adjust the paging DRX interval and the total number of groups, in accordance with the way to map the PCH to a subframe described above.

[0063]

For example, the parameter adjuster unit 15 is configured to adjust each paging DRX interval and the total number of groups, in accordance with the amount of incoming call for the
5 corresponding one of the mobile stations UE#1 to UE#3.

[0064]

The parameter adjuster unit 15 is also configured to adjust each paging DRX interval and the total number of groups, in accordance with the available bandwidth in the corresponding
10 cell.

[0065]

The parameter adjuster unit 15 is also configured to adjust each paging DRX interval and the total number of groups, in accordance with the frequency of change in the BCCH
15 (broadcast information) in the corresponding cell.

[0066]

As shown in Fig. 4, the mobile station UE includes a BCCH receiver unit 31, a PCH reception timing determining unit 32, a PCH receiver unit 33, and an incoming call processor unit 34.
20 [0067]

The BCCH receiver unit 31 is configured to receive the above-mentioned paging DRX interval and total number of groups, from the radio base station eNB through the BCCH.

[0068]

25 The BCCH receiver unit 31 may be configured to receive the subframe offset M, bitmap, or mapping pattern to be described later, from the radio base station eNB through the BCCH.

[0069]