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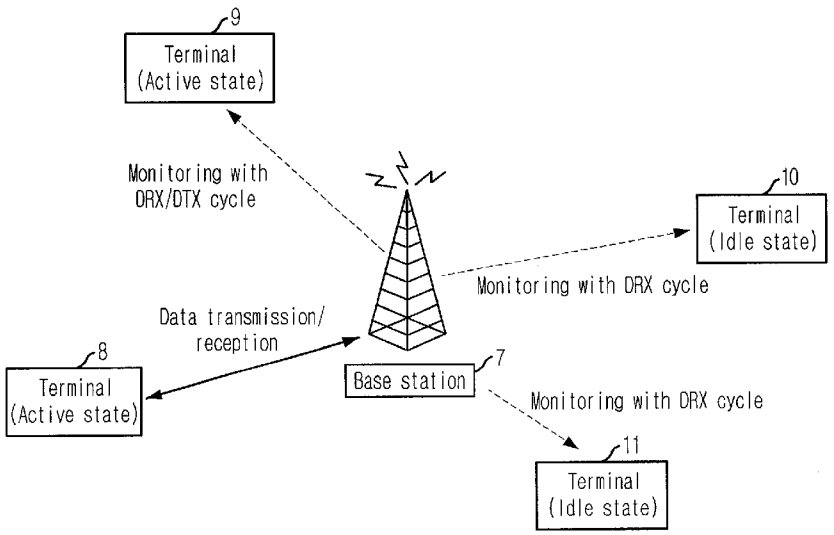
(54) **Title:** METHOD AND APPARATUS FOR DISCONTINUOUS TRANSMISSION/RECEPTION OPERATION FOR REDUCING POWER CONSUMPTION IN CELLULAR SYSTEM



(57) **Abstract:** Provided is a method and apparatus for discontinuously transmitting/receiving packets for low- power consumption of a terminal in a cellular system for packet transmission. The present research provides a method and apparatus that can perform a low-power consuming operation when a terminal is in active state in a cellular system. The method for discontinuously transmitting/receiving packet data to reduce power consumption of a terminal in a cellular system, including the steps of : a) establishing discontinuous reception/transmission (DRX/DTX) parameters including discontinuous DRX/DTX cycle information for terminals operating in a transmission suspension mode, which is a sub-state of an active state; and b) performing DRX/DTX based on the DRX/DTX parameters in the terminals operating in the transmission suspension mode.

WO 2007/073118 A1

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METHOD AND APPARATUS FOR DISCONTINUOUS TRANSMISSION/RECEPTION OPERATION FOR REDUCING POWER CONSUMPTION IN CELLULAR SYSTEM

Description

Technical Field

The present invention relates to a cellular system for packet services; and, more particularly, to a method and apparatus for discontinuously transmitting/receiving packets to reduce power consumption of a terminal in a cellular system for packet transmission.

Background Art

Terminals in a Wideband Code Division Multiple Access (WCDMA) Third-Generation Partnership Project (3GPP) system are divided into those of an active state where data can be transmitted and those of an idle state. Only terminals of the idle state perform discontinuous reception (DRX) to reduce their power consumption.

To perform the DRX, a DRX cycle is determined and used for monitoring according to a paging occasion in a paging channel (PCH), and the DRX cycle is determined in a network and the same DRX cycle is applied to all terminals within the coverage of a predetermined base station.

In other words, in the conventional 3GPP system, terminals in an idle mode operate in sleep mode (i.e., low-power consuming operation) to reduce power consumption by using the DRX cycle, which is a system parameter.

Whereas the WCDMA 3GPP system aims to provide circuit and packet services in a circuit-based system, a 3GPP Long-Term Evolution (LTE), which is under standardization process to provide diverse packet

services, is a packet-based system aiming to provide only a packet service.

Therefore, the conventional method of applying a DRX cycle only to idle-mode terminals and reducing the power consumption of the terminals is not appropriate to the LTE system which is devised to provide a packet service having a burst characteristic.

In short, it is required to develop a method that can reduce power consumption not only in idle-state terminals whose session for a packet service is terminated, but also in terminals whose session is not terminated yet but in an active state where data can be transmitted in a section where there is no data to be transmitted based on the burst characteristic of packet traffic to provide a packet service having a burst characteristic and diverse qualities of service (QoS).

Also, it is required to realize a method and apparatus that can reduce power consumption of a terminal by optionally determining parameters for discontinuous reception/transmission operation based on the QoS of a packet service provided by a cellular system such as a WCDMA 3GPP system to thereby minimize a processing time when a terminal switches between a transmission mode (Tx on) where the terminal transmits packet data and a transmission suspension mode (Tx off) where it does not transmit packet data; and efficiently operating the transmission suspension mode section where the terminal does not transmit packet data.

Disclosure

Technical Problem

It is, therefore, an object of the present invention devised to resolve the above problems to provide a method and apparatus that can perform a low-power consuming

operation when a terminal is in active state in a cellular system.

Also, it is another object of the present invention to provide a discontinuous reception/transmission (DRX/DTX) method and apparatus that can improve a power saving function of a terminal and minimize processing time needed for switching into a low-power consuming operation mode to thereby reduce power consumption of the terminal in a cellular system for transmitting packets by determining DRX/DTX parameters according to the quality of service (QoS) of a packet service provided by the cellular system for transmitting packets.

Other objects and advantages of the present invention can be understood by the following description, and become apparent with reference to the embodiments of the present invention. Also, it is obvious to those skilled in the art to which the present invention pertains that the objects and advantages of the present invention can be realized by the means as claimed and combinations thereof.

Technical Solution

In accordance with one aspect of the present invention, there is provided a method for discontinuously transmitting/receiving packet data to reduce power consumption of a terminal in a cellular system, comprising the steps of: a) establishing discontinuous reception/transmission (DRX/DTX) parameters including discontinuous DRX/DTX cycle information for terminals operating in a transmission suspension mode, which is a sub-state of an active state; and b) performing DRX/DTX based on the DRX/DTX parameters in the terminals operating in the transmission suspension mode.

Also, the discontinuous reception/transmission

method for reducing power consumption of a terminal in a cellular system transmitting packets, which is suggested in the present invention, includes the steps of establishing DRX/DTX parameters including DRX/DTX cycle information; and performing a low power-consuming operation based on the DRX/DTX parameters.

Also, a base station apparatus for discontinuously transmitting/receiving packet data to reduce power consumption of a terminal in a cellular system for transmitting packets, includes a terminal state management unit and a DRX/DTX control unit. The terminal state management unit manages and switches the state of the terminal according to whether the terminal is in an idle state or an active state. The DRX/DTX control unit establishes DRX/DTX parameters including DRX/DTX cycle information for terminals operating in a transmission suspension mode, which is a sub-state of the active state, and controls the DRX/DTX operation based on the DRX/DTX parameters.

Also, the DRX/DTX terminal of the present invention that has a reduced power consumption in a cellular system for transmitting packets includes a terminal state management unit and a low power-consuming operation unit. The terminal state management unit controls mode switching between a transmission suspension mode and a transmission mode, which are sub-states of the active state. The low power-consuming operation unit establishes DRX/DTX parameters including DRX/DTX cycle information and controls a terminal to perform a low power-consuming operation based on the DRX/DTX parameters while it is in the transmission suspension mode.

Advantageous Effects

The present invention increases the capacity of an

active-state terminal that can be accommodated by a base station by variably applying parameters for discontinuous reception/transmission (DRX/DTX) according to the type and QoS of a packet service provided by a cellular system for transmitting packets and efficiently utilizing limited radio resources for transmitting control information. The present invention also improves a power-saving function of a terminal and minimizes processing time needed for mode switching of the DRX/DTX by consuming only power needed for a reception module of the terminal according to a DRX/DTX cycle when there are no data to be transmitted.

In addition, the present invention can perform DRX/DTX operation not only in an idle state but in an active state to reduce power consumption of the terminal in a cellular system for transmitting packets.

Description of Drawings

Fig. 1 is a diagram illustrating a cellular system to which the present invention is applied.

Fig. 2 is a view describing operation of a terminal with a base station based on the state of the terminal in a cellular system in accordance with an embodiment of the present invention.

Fig. 3 is a block view showing a base station performing discontinuous reception/transmission for low power consumption in accordance with an embodiment of the present invention.

Fig. 4 is a block view showing a terminal performing discontinuous reception/transmission for low power consumption in accordance with an embodiment of the present invention.

Fig. 5 is a view showing the form of packet data which is applied to the present invention.

Fig. 6 is an exemplary view showing a DRX/DTX cycle allocated in accordance with an embodiment of the present invention.

Fig. 7 is a signaling flowchart between a base station and a terminal that perform discontinuous operation for low power consumption in accordance with an embodiment of the present invention.

Best Mode for the Invention

Other objects and aspects of the invention will become apparent from the following description of the embodiments with reference to the accompanying drawings, which is set forth hereinafter. Accordingly, those skilled in the art of the present invention can easily implement the technological concept of the present invention. Also, when it is considered that detailed description on a prior art related to the present invention may obscure the points of the present invention unnecessarily in the description of the present invention, the description will not be provided. Hereinafter, specific embodiments of the present invention will be described in detail with reference to the accompanying drawings.

Fig. 1 is a diagram illustrating a cellular system to which the present invention is applied.

A cellular system providing a packet service defines and manages the state of a terminal as shown in Fig. 1 to efficiently operate limited radio resources in nodes over a base station, i.e., a node B.

When a terminal is registered on a network through a base station, the state of the terminal is defined as an attached mode 1. When a terminal is not recognized on a cellular network and the base station, or when the terminal is not registered, the state of the terminal is

defined as a detached mode 2.

Terminals in the attached mode 1 are divided into those of an active state 3 and those of an idle state 4 according to whether or not a packet service is provided.

The active state 3 is a state where a terminal can be allocated with radio resources for transmitting/receiving packet data under the control of a scheduling unit disposed in a base station.

The active state 3 is divided into a transmission mode (Tx on) 5 and a transmission suspension mode (Tx off) 6 according to whether radio resources for transmitting packet data are allocated.

A conventional terminal performs a low power-consuming operation, which is so-called a power-saving operation, by maintaining only the least control channel with a base station only in the idle state 4 where there is no data to be transmitted/received based on the burst property of packet data. The terminal may enter the idle state 4 by a scheduling unit of a base station, regardless of the state of the terminal.

Fig. 2 is a view describing operation of a terminal with a base station based on the state of the terminal in a cellular system in accordance with an embodiment of the present invention.

As illustrated in Fig. 2, terminals 8, 9, 10 and 11 are disposed in a service coverage of a base station 7 in a cellular system for a packet service and receive a service by transmitting/receiving data to/from the base station 7.

Terminals disposed within a service coverage of a base station perform different operations according to the connection state shown in Fig. 1.

Terminals 10 and 11 in the idle state, which have not set up a data channel for transmitting/receiving data to/from a base station, monitor paging channel

information by informing reception of data for call setup transmitted from a base station according to a predetermined DRX cycle to reduce power consumption.

Meanwhile, active-state terminals are divided into those 8 that transmit/receive data to/from a base station and do not perform discontinuous reception/transmission (DRX/DTX) operation to reduce power consumption and those 9 that perform DRX/DTX operation for low power-consumption in the active state.

The terminals 9 that perform the DRX/DTX operation to reduce power-consumption in the active state monitor a message informing the reception of data transmitted from a base station according to a DRX/DTX cycle.

To make terminals perform the DRX/DTX operation for low power consumption in the active state, the base station 7 variably allocates a DRX/DTX cycle to terminals that do not transmit/receive data to/from the base station for a predetermined time according to the provided service among the terminals receiving a service. When downlink data are generated, a signaling message for informing the generation of the downlink data is transmitted according to the DRX/DTX cycle of the terminal.

Among the active-state terminals, those that have not transmitted/received data to/from the base station for more than a predetermined time performs DRX/DTX operation for low power consumption according to the DRX/DTX cycle allocated under the control of the base station. Terminals that perform DRX/DTX operation in the active state monitor a signaling message that informs the reception of downlink data for each DRX/DTX period and, when data to be transmitted through an uplink are generated, transmit a signaling message informing the generation of the data to thereby resume to receive the service.

Fig. 3 is a block view showing a base station performing discontinuous reception/transmission for low power consumption in accordance with an embodiment of the present invention.

Referring to Fig. 3, a base station includes a base station controller 110, a layer-2 processor 120, a transmitter 130, a radio frequency (RF) module 140, and a receiver 150.

The base station controller 110 includes a terminal state management unit 111, a DRX/DTX control unit 112, a scheduling unit 113, and a network access unit 114.

The terminal state management unit 111 and the DRX/DTX control unit 112 are constituent elements for controlling DRX/DTX operation of an active-state terminal for low power consumption.

The terminal state management unit 111 manages the terminal according to whether the terminal is in the idle state or the active state and controls state shift.

The scheduling unit 113 provides information on the terminals that have not transmitted/received data for more than a predetermined time to the terminal state management unit 111 and the DRX/DTX control unit 112 among the active-state terminals and determines whether to perform the DRX/DTX operation for low power-consumption.

The DRX/DTX control unit 112 receives information on the state of the terminals and information on where the terminals have transmitted/received data from the scheduling unit 113 and the terminal state management unit 111, determines whether to make the active-state terminals perform the DRX/DTX operation for low power-consumption, variably determines DRX/DTX parameters according to the quality of service of the provided packet service or the capability of each terminal, and outputs them to the layer-2 processor 120.

The layer-2 processor 120 generates a control message including the DRX/DTX parameters and outputs it to the transmitter 130.

The transmitter 130 receives the control message, codes the control message in a coding unit 131, performs radio resource mapping in a radio resource mapping unit 132, performs inverse Fast Fourier Transform (IFFT) in an IFFT unit 133, and transmits the result to the terminals through the RF module 140.

Fig. 4 is a block view showing a terminal performing discontinuous reception/transmission for low power consumption in accordance with an embodiment of the present invention.

Referring to Fig. 4, a terminal includes a terminal controller 210, a layer-2 processor 220, a transmitter 230, an RF module 240, and a receiver 250.

The RF module 240 receives signals from a base station to which the terminal belongs, i.e., where the terminal camps in, and outputs the signals to the receiver 250.

A terminal performing the DRX/DTX operation for low power consumption under the control of the base station operates the receiver 250 at every DRX/DTX cycle, extracts symbols by performing FFT process onto the signals of the base station inputted from the RF module 240, performs symbol mapping onto the received signals based on base station modulation information included in the control information in the symbol mapping unit 252, and outputs the result to the decoding unit 54.

The decoding unit 253 decodes the symbols transmitted from the symbol mapping based on base station information included in the control information and outputs extracted packet information to the layer-2 processor 220.

The layer-2 processor 220 outputs information

received at the DRX/DTX cycle to the terminal state management unit 211 and the low-power consuming operation unit 212 of the terminal controller 210.

The terminal state management unit 211 and the low-power consuming operation unit 212 determine to perform low-power consuming operation and maintain the current state, when there is no downlink signal reception information within the inputted packet information. When there is downlink signal reception information, the low-power consuming operation unit 212 determines to suspend the low power consuming operation, and the terminal state management unit 211 controls the shifting from the transmission suspension mode into a transmission mode.

With no regard to the control of the base station on the reception of the downlink information, when data to be transmitted in the uplink are generated, the terminal controller 210 controls the terminal state management unit 211 and the low power consuming operation unit 212 to suspend the low-power consuming operation, determines to initiate the uplink transmission in the scheduling unit 213 regardless of the DRX/DTX cycle, generates a control message in the layer-2 processor 220, and transmits uplink packet information to the base station through the transmitter 230 and the RF module 240.

Fig. 5 is a view showing the form of packet data which is applied to the present invention.

Referring to Fig. 5, an active-state terminal defines a transmission mode as a state that packet calls 51 burst out due to the characteristics of packet data and occupies radio resources allocated by a scheduling unit to transmit the packet data. When there is no packet data to be transmitted, such as a reading time 52, the terminal defines the state as a transmission suspension mode where the base station performs low power consuming operation.

Also, when the base station and the terminal recognize terminal of all sessions on service or if needed, they can shift the terminal into an idle state.

For the state shift and mode switching, they can set up DRX/DTX parameters according to the type or QoS of a packet service, and include the DRX/DTX parameters in system information transmitted through a broadcasting channel.

The DRX/DTX parameters include a DRX/DTX cycle initial value, a minimum DRX/DTX cycle, a DRX/DTX cycle augmentative coefficient, a duration applying a same DRX/DTX cycle, a transmission mode residue threshold value, and a transmission suspension mode residue threshold value.

The DRX/DTX cycle initial value is a DRX/DTX cycle value applied to the initial period of the transmission suspension mode.

The minimum DRX/DTX cycle is the minimum value of a coefficient for setting up a DRX/DTX cycle that is applied to the radio resource allocation for transmitting control information of a terminal that the scheduling unit of a base station has switched into a transmission suspension mode.

The DRX/DTX cycle augmentative coefficient is a coefficient value for indicating an increased amount when the DRX/DTX cycle of terminals which are switched into the transmission suspension mode and perform the DRX/DTX operation.

The duration applying a same DRX/DTX cycle is a value of a counter or a value set up as time to increase a DRX/DTX cycle after maintaining it uniformly as long as a duration applying a same DRX/DTX cycle, when the DRX/DTX cycle is increased as much as the DRX/DTX cycle augmentation coefficient during the operation of transmission suspension mode.

The transmission mode residue threshold value is a threshold value that the terminal can remain in the transmission mode without packet data to be transmitted in the transmission buffers of the base station and the terminal.

The transmission suspension mode residue threshold value is a threshold value that a terminal can operate in the transmission suspension mode when the terminal does not or cannot recognize the termination of a provided packet service.

When there are packet data in the transmission buffers of the base station and the terminal, the terminal operates in the transmission mode, which is a sub-state of the active state, and the scheduling unit occupies allocated radio resources and transmits data. The scheduling unit can switch the terminal from the transmission mode into the transmission suspension mode in the following situations:

- when packet data are not generated until the base station and the terminal set up a buffer timer at a buffer empty moment that all data to be transmitted are transmitted and the transmission buffers of the base station and the terminal become empty and begin counting, and the timer value exceeds the transmission mode residue threshold value.

- when it is impossible to allocate radio resources due to a poor radio communication environment between a node B and the terminal.

- when the scheduling unit determines to switch the terminal mode into the transmission suspension mode for other reasons.

The base station can efficiently use limited radio resources for transmitting control information that should be allocated to the active-state terminals by

switching some terminals into the transmission suspension mode in the above occasions.

Also, when there is no data to be transmitted that burst out, the terminals operate in the transmission suspension mode perform discontinuous transmission (DTX) to reduce their power consumption by using the uplink radio resources for transmitting control information, which are allocated according to the DRX/DTX cycle and reporting the terminal buffer state and reporting the quality of an estimated downlink channel.

Furthermore, the process time taken for switching between the transmission mode and the transmission suspension mode can be minimized by properly establishing and operating the DRX/DTX cycle between the base station and the terminal, and using an indicator for informing the presence of downlink traffic at every DRX/DTX cycle and radio resources allocated to the uplink to request to switch the mode.

When the base station is switched between the transmission mode and the transmission suspension mode, it discusses and determines DRX/DTX parameters for each terminal according to the terminal and the QoS of the provided packet service, and informs them to the terminal through a control channel. In the meantime, when there is no discussing process between the base station and the terminals, the terminals performs DRX/DTX operation according to the DRX/DTX parameters transmitted through a broadcasting channel.

The DRX/DTX cycle is determined according to the DRX/DTX parameters, which are determined between the base station and the terminals, based on the following algorithm:

when n>0 and n mod duration applying a same DRX/DTX cycle is equal to 0,

DRX/DTX cycle(n+1) = DRX/DTX cycle (n) * DRX/DTX cycle augmentation coefficient.

In other cases,

DRX/DTX cycle(n+1) = DRX/DTX cycle (n)

where n = 0,1,2,3...,i

DRX/DTX cycle(0) = DRX/DTX cycle initial value

DRX/DTX cycle augmentation coefficient = 1,2,3...,j

duration applying a same DRX/DTX cycle = time duration (or a threshold value of a counter) to which the same DRX/DTX cycle is applied

Fig. 6 is an exemplary view showing a DRX/DTX cycle allocated in accordance with an embodiment of the present invention.

When the DRX/DTX cycle initial value 63, DRX/DTX cycle augmentation coefficient and duration applying a same DRX/DTX cycle 61 of an active-state terminal operating in the transmission suspension mode (Tx off) are respectively 50 milliseconds, 2 and 500 milliseconds (or the counter threshold value is determined at 10), an identical DRX/DTX cycle is applied in the DRX/DTX cycle sustaining section 61, and another DRX/DTX cycle which is increased by the previous DRX/DTX cycle based on the DRX/DTX cycle augmentation coefficient is applied in the next duration applying a same DRX/DTX cycle 61 according to the algorithm of Fig. 6. In other words, a DRX/DTX cycle initial value of 50 milliseconds is applied in the initial duration applying a same DRX/DTX cycle, and 100 milliseconds, which is twice as much as the DRX/DTX cycle initial value, is applied in the next duration applying a same DRX/DTX cycle. Whenever one duration applying a same DRX/DTX cycle ends ((n mod duration applying a same DRX/DTX cycle)=0), the DRX/DTX cycle increases twice as much according to the DRX/DTX cycle augmentation coefficient.

To be specific, the terminal enters into the transmission suspension mode and performs low power-consuming operation to thereby consume the least amount of power needed by the receiver during the DRX/DTX cycle of 50ms and suspend the operation of the transmitter and the most part of the receiver. At the end of the 50ms-DRX/DTX cycle, the terminal monitors radio resources for transmitting a traffic indicator and uplink control information. In the monitoring duration, when the terminal finds out no data to be transmitted in the uplink or no information indicating downlink data reception, the terminal performs the low power-consuming operation according to the DRX/DTX cycle. In the example of parameters, the identical DRX/DTX cycle is applied during the duration applying a same DRX/DTX cycle, i.e., 500ms, and after fall 10 monitoring durations occurs in one duration applying a same DRX/DTX cycle. When a counter is employed, the counter number increases by 1 whenever one DRX/DTX cycle passes. To sum up, in the above case, the counter number increases by 1 at every 50ms and one DRX/DTX cycle is applied until the counter number becomes 10.

Therefore, the terminal determines based on the algorithm whether it is in or out of a duration applying a same DRX/DTX cycle, whenever one DRX/DTX cycle ends. When n>0, (n mod duration applying a same DRX/DTX cycle) = 0. When the timer of the terminal or an independent DRX/DTX cycle counter indicates the end of a duration applying a same DRX/DTX cycle, the terminal performs calculation to obtain a DRX/DTX cycle to be applied in the next duration applying a same DRX/DTX cycle based on the above algorithm equation.

When the DRX/DTX cycle augmentation coefficient is determined to be 1 regardless of parameters of the duration applying a same DRX/DTX cycle, the DRX/DTX cycle

of the terminal, which is in the transmission suspension mode, becomes the DRX/DTX cycle initial value 63 all through the transmission suspension mode.

The DRX/DTX parameters including the DRX/DTX cycle initial value 63 are variably determined according to the type of a packet service and the QoS.

For example, in case of a real-time voice of IP (VoIP) service, low power-consuming operation can be performed based on the DRX/DTX cycle initial value by setting up the DRX/DTX cycle initial value at 20ms and the DRX/DTX cycle augmentation coefficient to be '1' regardless of the duration applying a same DRX/DTX cycle parameter, and limiting the variation of the DRX/DTX cycle. To sum up, in a real-time service, overhead caused by transmitting control information can be reduced by fixing the DRX/DTX cycle and allocating radio resources periodically based on the DRX/DTX cycle without transmitting an additional control message for the allocation of radio resources, e.g., L1/L2 control signaling, and the QoS of a service required by the system can be achieved while reducing the power consumption of the terminal. Herein, the DRX/DTX cycle initial value for each terminal may be set up differently according to the type of the real-time service and the capacity of the terminal.

Meanwhile, a short DRX/DTX cycle initial value may be determined in a non-real time http service for the Internet Access to reduce delay time until data are retransmitted to the low power-consuming terminals. Generally, however, the DRX/DTX cycle initial value may be determined relatively larger than that of a real-time service. The throughput of a system can be improved by determining the duration applying a same DRX/DTX cycle to be a multiple of a Transmission Time Interval (TTI) based on the statistical characteristic of a packet service in

consideration of the load on a base station, determining the DRX/DTX cycle augmentation coefficient to be 2 or higher, and varying the DRX/DTX cycle. In short, a non-real time service is not sensitive to delay of packet data and its activity is not predicted. Therefore, it is desirable to determine the DRX/DTX cycle initial value of a non-real time service larger than that of a real-time service according to the load on a base station, type of non-real time service, and capacity of a terminal, and varying the DRX/DTX cycle based on the parameters of the duration applying a same DRX/DTX cycle and the parameters of the DRX/DTX cycle augmentation coefficient. The method has a shortcoming that the base station and the terminal should exchange a control message for allocating radio resources to transmit packet data by varying the DRX/DTX cycle. However, it can efficiently reduce the power consumption of the terminal.

A base station allocates a traffic indicator for informing that there are packet data to be transmitted from the base station to each of the terminals operating in the transmission suspension mode, and radio resources 62 for transmitting control information in the uplink for each DRX/DTX cycle.

When a terminal operating in the transmission suspension mode receives an indicator informing that there are packet data to be received from the base station in the downlink, it transmits control information for switching the mode through the uplink radio resources 62 allocated by the base station and is switched into the transmission mode.

Also, the terminal operating in the transmission suspension mode transmits the control information such as the state of a terminal buffer and downlink channel quality by using the uplink radio resources 62 allocated for each DRX/DTX cycle and, when there are data to be

transmitted, it transmits the control information including a mode switching request into the transmission mode by using the allocated uplink radio resources 62.

Fig. 7 is a signaling flowchart between a base station and a terminal that perform discontinuous operation for low power consumption in accordance with an embodiment of the present invention.

The base station determines DRX/DTX parameters based on the type and QoS of the packet service to shift the state and switch the mode of the idle terminal, generates system information including the DRX/DTX parameters, and transmits it through a broadcasting channel at step S711.

At step S712, when packet data are generated, the base station attempts to provide a service corresponding to the packet data. Herein, the base station attempts to provide a service through paging, and the terminal receives system information during a paging monitoring section and attempts to access in a random access method to provide the service corresponding to the generated packet data.

At step S721, the terminal is shifted into the active state by controlling the state shift, and the terminal whose mode is shifted into the active state operates in the transmission mode at step S722, and the base station and terminal establishes session for the packet data service at step S723.

Subsequently, when the transmission buffers of the base station and the terminal remain empty in the transmission mode and there is no attempt for a new service (buffer information timer > transmission mode residue threshold value), the terminal switches its mode into the transmission suspension mode and performs DRX/DTX at steps S724 and S725. The base station and terminal discus and set up the DRX/DTX parameters at step S726, and the base station transmits traffic presence

indicator according to the DRX/DTX cycle and allocates radio resources for transmitting uplink control information at step S727.

Subsequently, when the terminal detects a downlink traffic indicator during the DRX/DTX operation in the transmission suspension mode or there are data to be transmitted, the terminal is switched into the transmission mode upon the state shift control (at step S728) of the base station at step S729, and attempts to transmit the packet data or attempts to provide a new service at step S730, and cancels the session at step S731 when the packet data service ends. At the step S730, the base station attempts to provide the service based on MAC paging, and when there is no uplink synchronization, the terminal attempts to provide the service through random access. When the uplink synchronization is achieved, the terminal attempts to provide the service by using the available radio resources for transmitting the control information. The MAC paging is a method that an MAC takes the initiative and informs the terminal of the generation of data to be transmitted through downlink, instead of the Radio Resource Control (RRC). It is different from RRC-controlled paging. An example of the MAC paging is to inform transmission of scheduling information.

Meanwhile, when the terminal is in the transmission suspension mode and the transmission suspension mode residue timer is larger than the transmission suspension mode residue threshold value or a session termination signal is generated, it shifts into the idle state at step S732.

Also, when the terminal is in the transmission mode and the transmission mode residue timer is larger than the transmission mode residue threshold value or a session termination signal is generated, it shifts into

the idle state at the step S732, too.

The method of the present invention can be realized as a program and stored in a computer-readable recording medium such as CD-ROM, RAM, ROM, floppy disks, hard disks, and magneto-optical disks. Since the process can be easily implemented by those skilled in the art to which the present invention pertains, detailed description on it will not be provided herein.

While the present invention has been described with respect to certain preferred embodiments, it will be apparent to those skilled in the art that various changes and modifications may be made without departing from the scope of the invention as defined in the following claims.

Industrial Applicability

The present invention is applied to a cellular system.

What is claimed is:

1. A method for discontinuously transmitting/receiving packet data to reduce power consumption of a terminal in a cellular system, comprising the steps of:

a) establishing discontinuous reception/transmission (DRX/DTX) parameters including discontinuous DRX/DTX cycle information for terminals operating in a transmission suspension mode, which is a sub-state of an active state; and

b) performing DRX/DTX based on the DRX/DTX parameters in the terminals operating in the transmission suspension mode.

2. The method as recited in claim 1, wherein the DRX/DTX parameters further include a DRX/DTX cycle augmentation coefficient and a DRX/DTX cycle suspension section.

3. The method as recited in claim 2, wherein the DRX/DTX parameters further include:

a transmission mode residue threshold value indicating a threshold value that one of a terminal and a base station remains in a transmission mode without packet data to be transmitted to a transmission buffer of one of the base station and the terminal; and

a transmission suspension mode residue threshold value indicating a threshold value that the terminal operates in the transmission suspension mode.

4. The method as recited in any one of claims 1 to 3, wherein the step a) further includes the steps of:

a1) transmitting the DRX/DTX parameters based on the system information transmitted through a broadcasting

channel.

5. The method as recited in any one of claims 1 to 3, wherein the DRX/DTX parameters are established based on any one between the type and quality of service (QoS) of a packet service provided to the terminal in the step a).

6. The method as recited in claim 5, wherein when the packet service is a non-real time service, a DRX/DTX cycle is variably established in the step a).

7. The method as recited in claim 5, wherein when the packet service is a real-time service, a DRX/DTX cycle is fixed in the step a).

8. The method as recited in any one of claims 1 to 3, wherein the step b) includes the step of:

b1) establishing a traffic presence indicator for informing the presence of packet traffic that the terminal is to receive and transmitting the traffic presence indicator based on the DRX/DTX cycle to each of the terminals operating in the transmission suspension mode.

9. The method as recited in any one of claims 1 to 3, wherein the step b) includes the step of:

b2) allocating uplink radio resources to the terminals operating in the transmission suspension mode based on the DRX/DTX cycle, and notifying the allocation.

10. The method as recited in claim 9, wherein the step b) further includes:

b3) receiving buffer state information of each terminal through the uplink radio resources allocated

based on the DRX/DTX cycle from the terminals operating in the transmission suspension mode.

11. The method as recited in claim 9, wherein the step b) further includes the step of:

b4) receiving a mode switching request into a transmission mode through the uplink radio resources allocated based on the DRX/DTX cycle from the terminals operating in the transmission suspension mode.

12. The method as recited in claim 2, wherein the step b) further includes the step of:

b5) performing DRX/DTX by applying a DRX/DTX cycle to one DRX/DTX sustaining section, and increasing the DRX/DTX cycle whenever the DRX/DTX sustaining section ends.

13. The method as recited in claim 2, wherein the step a) includes the step of:

a1) whenever the duration applying a same DRX/DTX cycle ends, establishing the DRX/DTX cycle based on the following equation:

DRX/DTX cycle(n+1) = DRX/DTX cycle(n) * DRX/DTX cycle augmentation coefficient

where the DRX/DTX cycle denotes the cycle of discontinuous reception/transmission; the duration applying a same DRX/DTX cycle denotes a cycle sustaining section of discontinuous reception/transmission; and the DRX/DTX cycle augmentation coefficient denotes a cycle increasement coefficient of discontinuous reception/transmission.

14. The method as recited in claim 3, further comprising the step of:

c) switching a terminal operating in a transmission

mode into the transmission suspension mode based on the transmission mode residue threshold value.

15. The method as recited in claim 3, further comprising the step of:

d) shifting the terminal operating in the transmission suspension mode into an idle state based on the transmission suspension mode residue threshold value.

FIG. 1

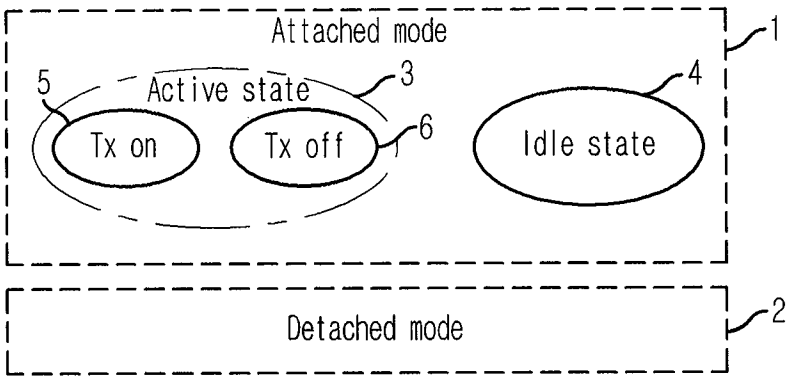

Attached mode
1
5
Active state
3
4
Tx on
Tx off
6
Idle state
Detached mode
2

FIG. 2

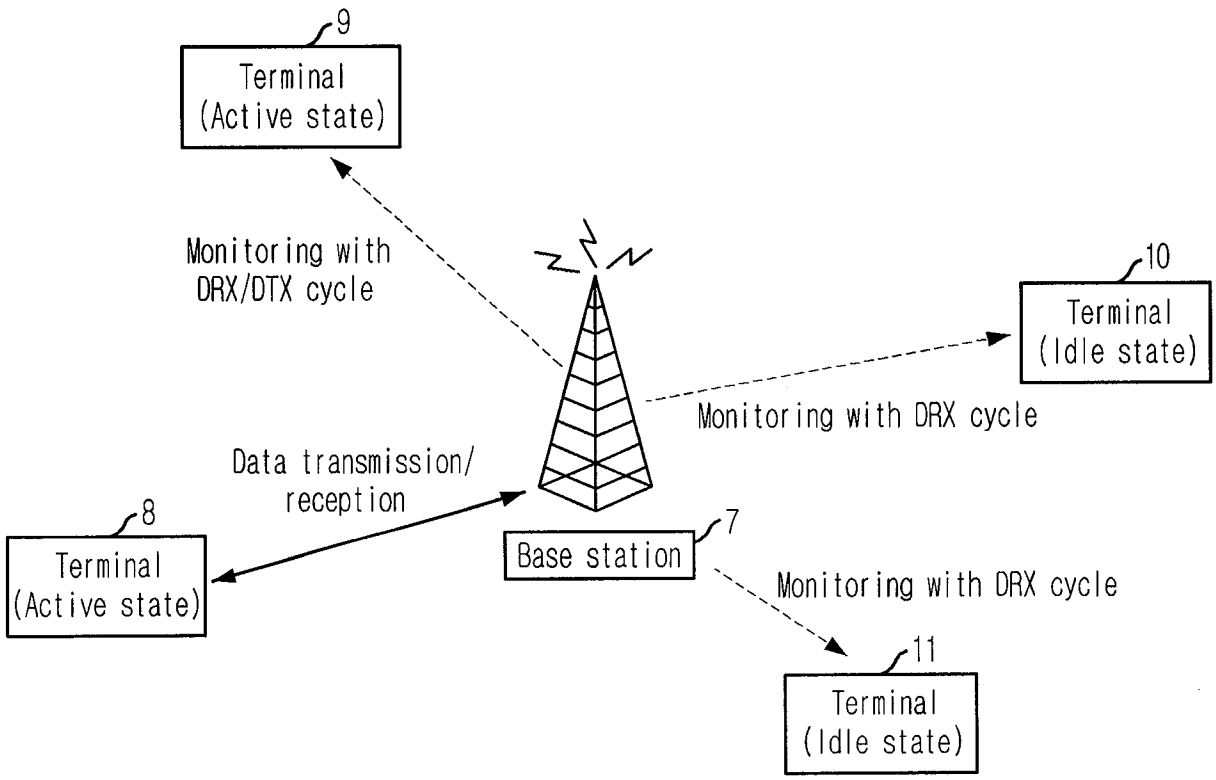

9
Terminal
(Active state)
Monitoring with
DRX/DTX cycle
10
Terminal
(Idle state)
Monitoring with DRX cycle
Data transmission/
reception
8
Terminal
(Active state)
Base station
7
Monitoring with DRX cycle
11
Terminal
(Idle state)

FIG. 3

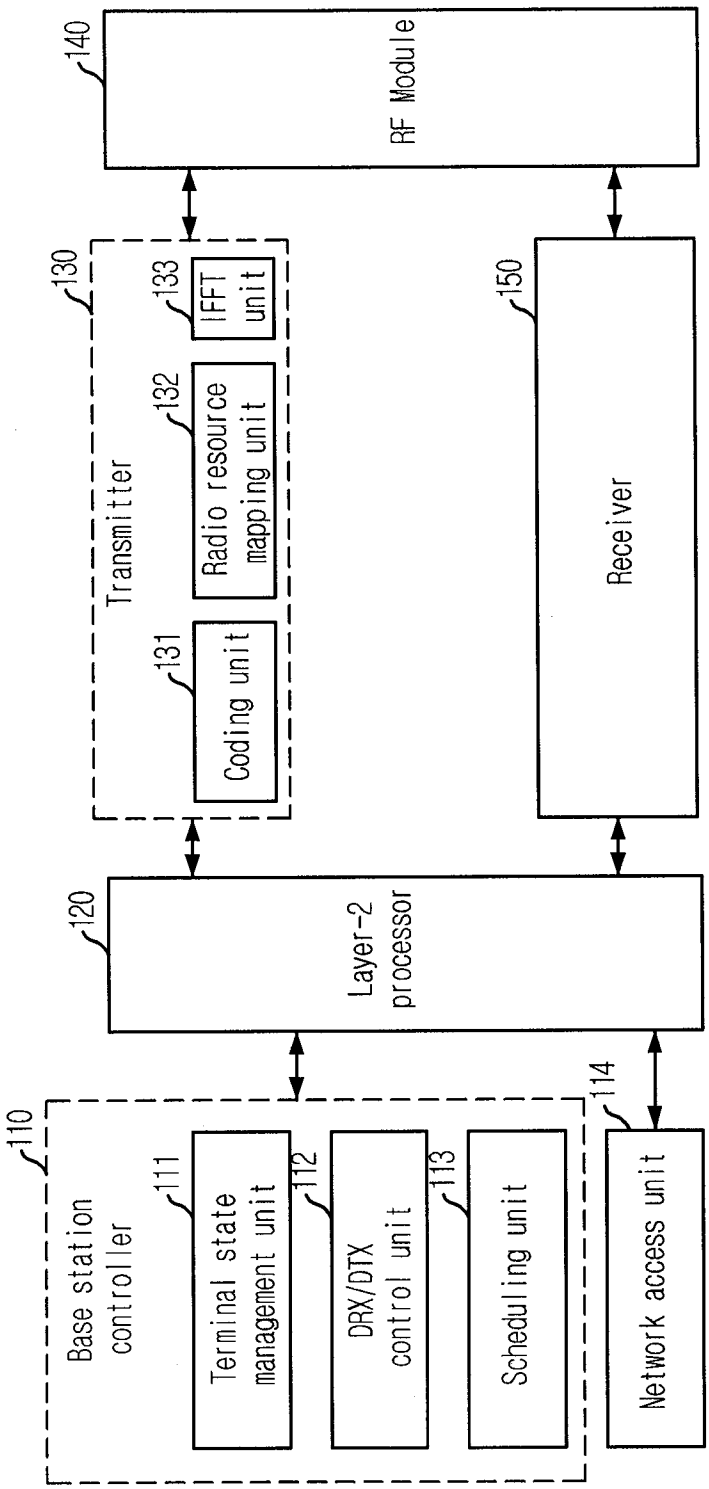

140
RF Module
130
Transmitter
133
IFFT unit
132
Radio resource mapping unit
131
Coding unit
150
Receiver
120
Layer-2 processor
110
Base station controller
111
Terminal state management unit
112
DRX/DTX control unit
113
Scheduling unit
114
Network access unit

FIG. 4

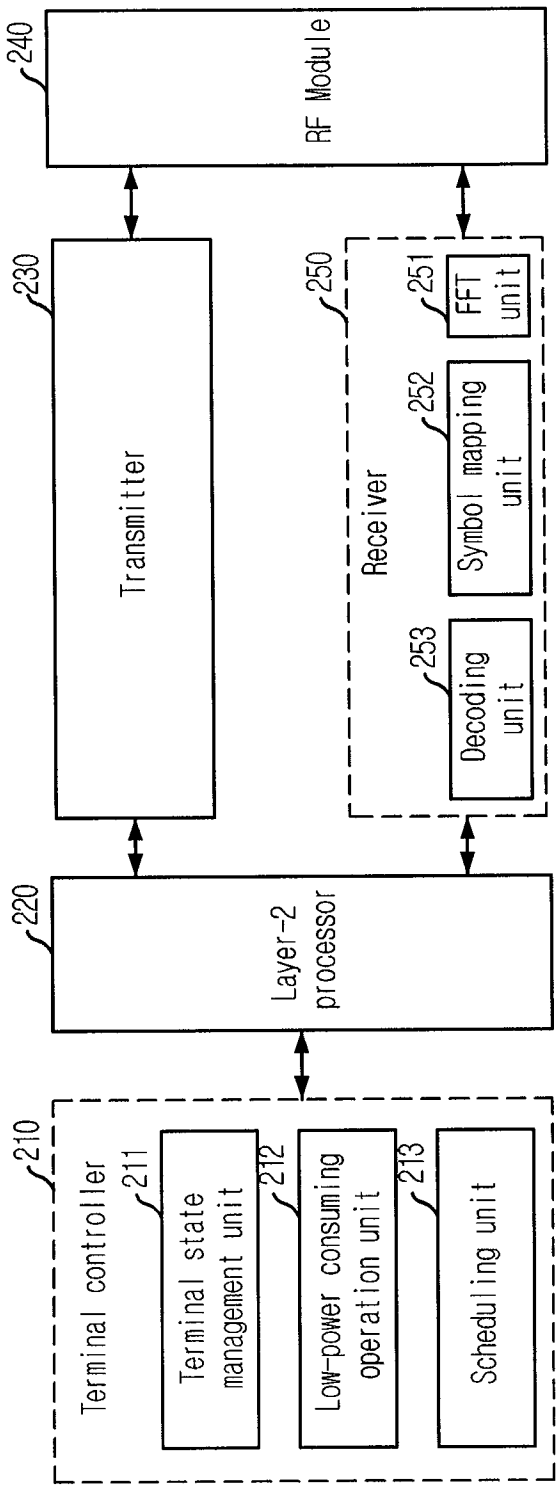

240
RF Module
230
Transmitter
250
Receiver
251
FFT unit
252
Symbol mapping unit
253
Decoding unit
220
Layer-2 processor
210
Terminal controller
211
Terminal state management unit
212
Low-power consuming operation unit
213
Scheduling unit

FIG. 5

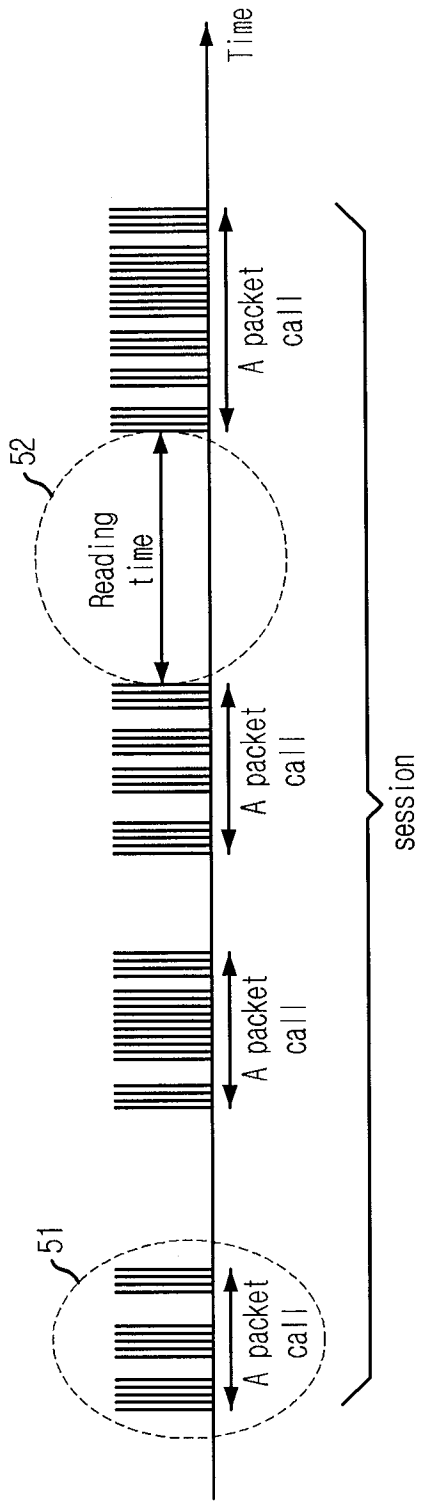

Time
A packet call
52
Reading time
A packet call
A packet call
session
51
A packet call

FIG. 6

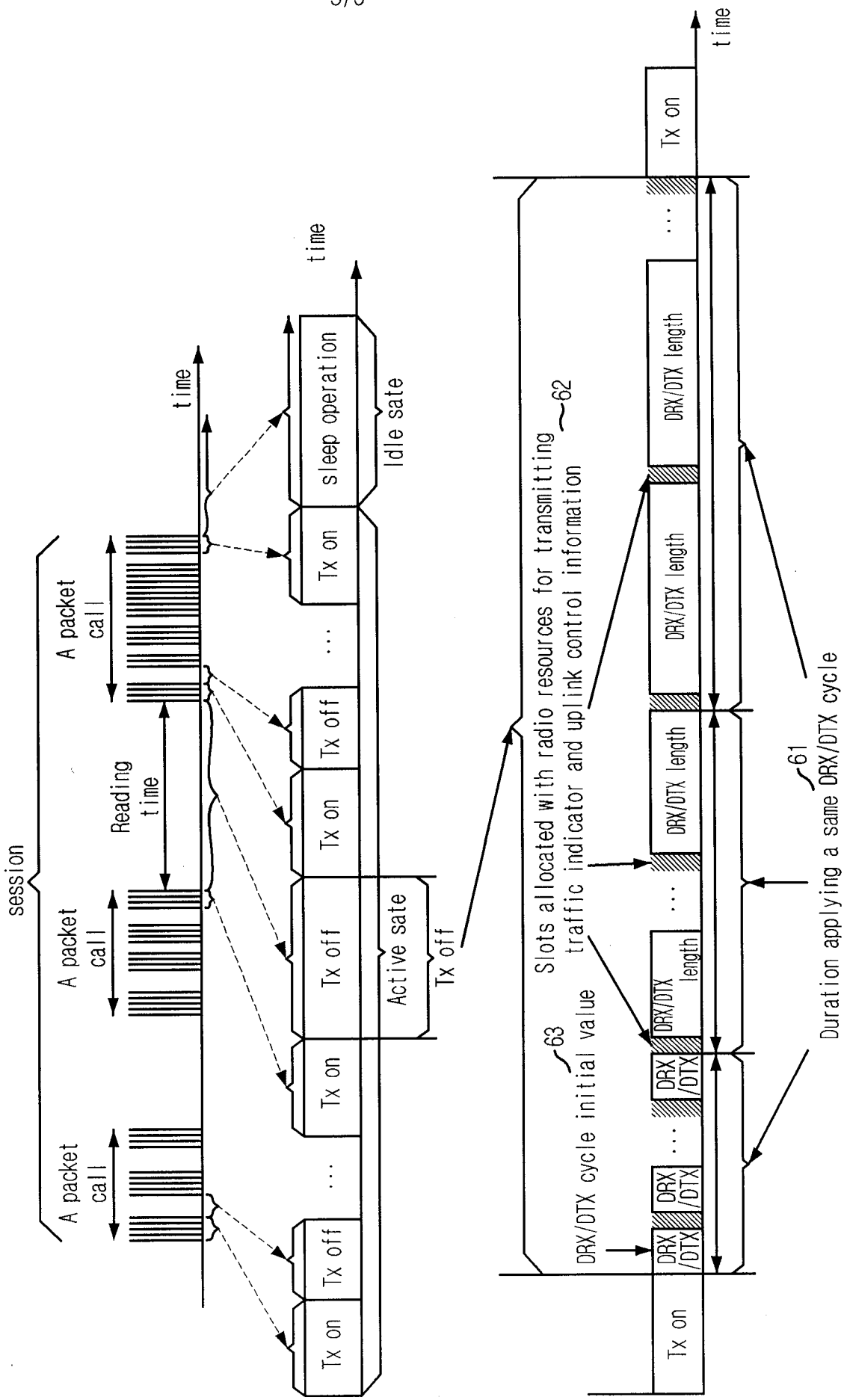
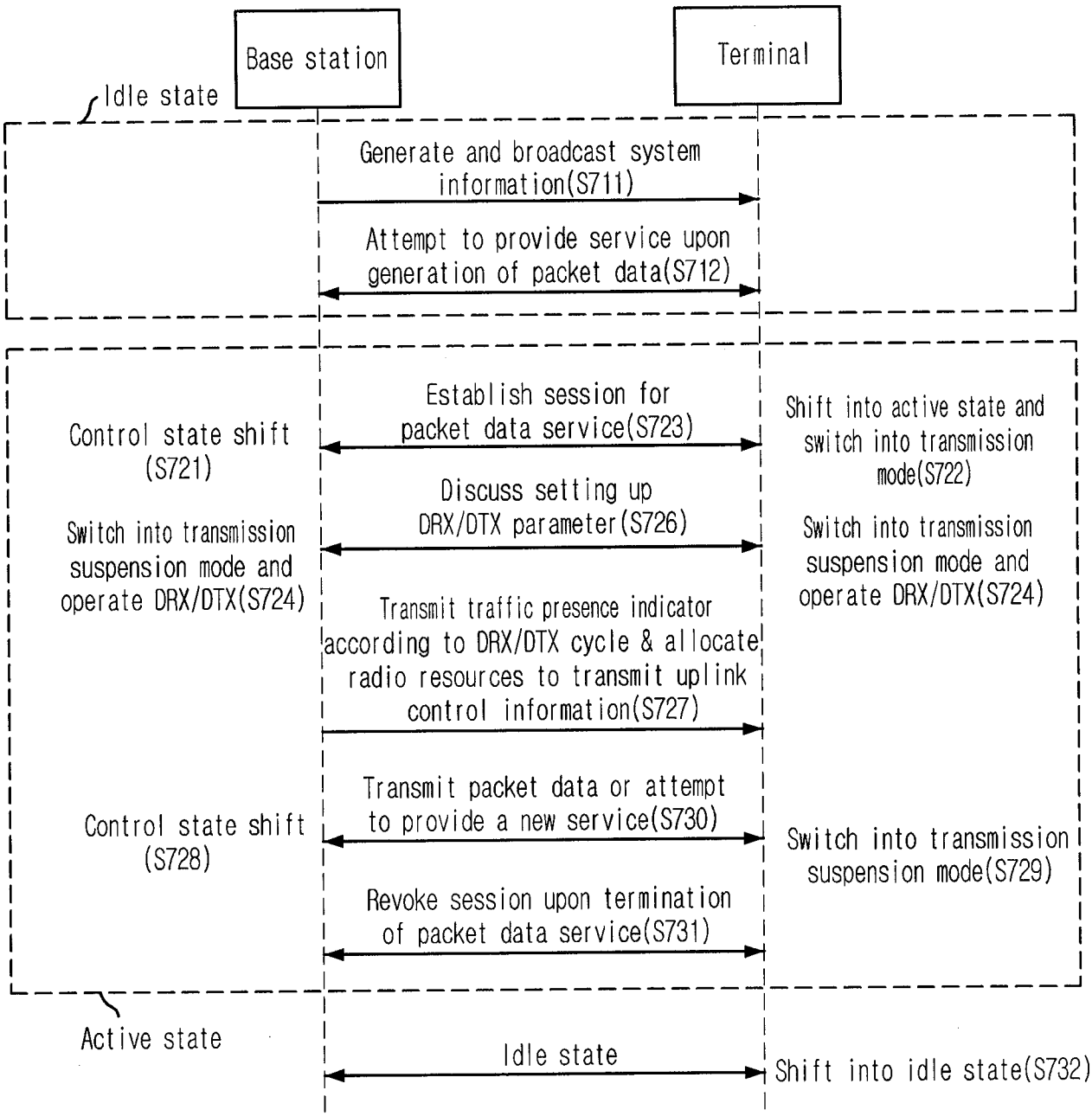

session
A packet call
A packet call
A packet call
Reading time
time
Tx on
Tx off
Tx off
Tx on
Tx off
Tx on
Active sate
Tx off
Tx on
sleep operation
Idle sate
time
Slots allocated with radio resources for transmitting traffic indicator and uplink control information
62
DRX/DTX cycle initial value
63
DRX /DTX
DRX/DTX length
61
Duration applying a same DRX/DTX cycle
Tx on
time

FIG. 7


Base station
Terminal
Idle state
Generate and broadcast system information(S711)
Attempt to provide service upon generation of packet data(S712)
Establish session for packet data service(S723)
Shift into active state and switch into transmission mode(S722)
Control state shift (S721)
Discuss setting up DRX/DTX parameter(S726)
Switch into transmission suspension mode and operate DRX/DTX(S724)
Switch into transmission suspension mode and operate DRX/DTX(S724)
Transmit traffic presence indicator according to DRX/DTX cycle & allocate radio resources to transmit uplink control information(S727)
Transmit packet data or attempt to provide a new service(S730)
Control state shift (S728)
Switch into transmission suspension mode(S729)
Revoke session upon termination of packet data service(S731)
Active state
Idle state
Shift into idle state(S732)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2006/005664

A. CLASSIFICATION OF SUBJECT MATTER

H04B 7/26(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC8 H04B 7/26, H04Q 7/00, 7/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
KOREAN PATENTS AND APPLICATIONS FOR INVENTIONS SINCE 1975
KOREAN UTILITY MODELS AND APPLICATIONS FOR UTILITY MODELS SINCE 1975

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search terms used)
eKIPASS, DELPHION, ESPACENET & Keywords : WCDMA, LTE, DRX, DTX, cycle, PCH, idle, active and similar terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US2005-176474 A1 (LEE et al.) 11 August 2005 * abstract, paragraphs [0057]-[0060], figure 6 *	1-15
A	WO2001-95648 A1 (NOKIA MOBILE PHONES LIMITED et al.) 13 December 2001 * abstract, page 9 line 28 - page 12 line 15, figures 3A-3B *	1-15
A	US 6,377,803 B1 (RUOHONEN) 23 April 2002 * abstract, Col. 6 line 17 - line 40, figures 5-6 *	1-15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 MARCH 2007 (23.03.2007)	**23 MARCH 2007 (23.03.2007)**

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Facsimile No. 82-42-472-7140

Authorized officer
KIM, Sang Woo
Telephone No. 82-42-481-8324

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/KR2006/005664

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US2005-176474 A1	11.08.2005	US2005176474AA	11.08.2005
WO2001-95648 A1	13.12.2001	AU200155019A1	17.12.2001
		AU200155019A5	17.12.2001
		US7075907BA	11.07.2006
US 6,377,803 B1	23.04.2002	AU199953754A1	21.03.2000
		DE69912455C0	04.12.2003
		DE69912455T2	22.07.2004
		EP01108315A1	20.06.2001
		EP01108315B1	29.10.2003
		FI107861B1	15.10.2001
		FI981855A0	28.08.1998
		FI981855A	29.02.2000
		JP2002524921T2	06.08.2002
		US6377803BA	23.04.2002
		WO200013377A1	09.03.2000