DESCRIPTION

MOBILE STATION, WIRELESS ACCESS NETWORK APPARATUS, MOBILE COMMUNICATION SYSTEM AND COMMUNICATION METHOD

TECHNICAL FIELD

The present invention relates to a call connection method in a mobile communication system, and particularly, to a mobile station, a wireless access network device, a mobile communication system, and a communication method for controlling transmission timing of channels used for the call connection.

BACKGROUND OF THE INVENTION

In a mobile communication system, setting up a connection between a mobile station and a wireless access network device is started upon a connection request from the mobile station or the wireless access network device.

FIG. 1 is a sequence diagram exemplifying a sequence of setting up a connection between a mobile station and a wireless access network device when the connection request is made from the side of the mobile station.

As shown in FIG. 1, first, the mobile station transmits a radio resource control (RRC) connection request signal through a random access channel (RACH), which is mapped into (namely, associated with) a physical random access channel (PRACH) (in other words, transmitting the random access channel (RACH), which is a transport channel, with the physical random access channel (PRACH), which is a physical channel.

After receiving the RRC connection request signal, the wireless access network device transmits a RRC connection set-up signal through a forward access channel (FACH), which is mapped into a secondary common control physical channel (SCCPCH).

Next, after receiving the RRC connection setup

signal, the mobile station switches to a dedicated physical channel (DPCH), and transmits a RRC connection setup complete signal. After that, signal transmission and reception are performed with the dedicated physical channel (DPCH).

As described above, in the related art, the mobile station and the wireless access network device need to switch, before the connection setup is completed, the physical channel for signal transmission and reception from the physical random access channel (PRACH), which is an uplink common physical channel, to the secondary common control physical channel (SCCPCH), which is a downlink common channel, and further to the dedicated physical channel (DPCH).

In addition, after the mobile station transmits the radio resource control (RRC) connection request signal, if the mobile station fails to receive the RRC connection set-up signal from the wireless access network device within a time period T300, which is designated by the wireless access network device in advance, the mobile station needs to repeatedly execute the above connection operations up to the number of times (N300) designated by the wireless access network device.

For example, this technique is disclosed in "3GPP TS 25.331 v6.5.0".

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

However, the above technique involves the following problems.

After the mobile station transmits the radio resource control (RRC) connection request signal through the physical random access channel (PRACH), the wireless access network device, which receives the RRC connection request signal, transmits the RRC connection set-up signal to the mobile station through the forward access channel

(FACH), which is mapped into a secondary common control physical channel (SCCPCH).

Since transmission of the RRC connection set-up signal is performed at any timing, the mobile station has to be constantly maintained in a state for receiving the forward access channel (FACH) signal, and to determine whether the RRC connection set-up signal for itself exists or not.

Since the mobile station constantly maintained in a state for receiving the forward access channel (FACH) signal also receives messages transmitted toward other mobile stations, the mobile station has to determine whether a message is for it or not. For this reason, the mobile station performs signal reception operations even when there is not a message sent to it, and this causes consumption of the battery power.

In addition, when the mobile station fails to receive the RRC connection set-up signal from the wireless access network device within a time period T300, which is designated by the wireless access network device in advance, the mobile station has to transmit the radio resource control (RRC) connection request signal again. If the mobile station still fails to receive the RRC connection set-up signal within the time period T300 after re-sending the radio resource control (RRC) connection request signal, the mobile station has to repeat transmission of the radio resource control (RRC) connection request signal once again. Further, this operation will be repeated for N300 number of times, which number is also designated by the wireless access network device in advance. Due to this, a connection delay and battery power consumption increase, and in the worst case, a connection delay of N300 times T300 may arise.

Further, after receiving the RRC connection set-up signal, the mobile station transmits a RRC connection set-up complete signal through the dedicated physical channel (DPCH). Before transmitting the signal through the

dedicated physical channel(DPCH), it is necessary for the mobile station to set up the dedicated physical channel(DPCH), and obtain synchronization in the dedicated physical channel (DPCH). For this reason, a signal length increases due to additional channel set-up information, and re-synchronization due to DPCH switching costs time. In addition, during synchronization set-up between the mobile station and the wireless access network device, signal transmission and reception are disabled, and this causes further delay.

An object of the present invention is to provide a mobile station, a wireless access network device, a mobile communication system, and a communication method able to reduce a connection delay, and lower the power consumption.

METHODS TO SOLVE THE PROBLEMS

According to an aspect of the present invention, there is provided a mobile station for bi-directional communications with a wireless access network device, comprising: a connection set-up signal reception timing calculation unit that calculates a reception timing of a connection set-up signal when a connection request signal is transmitted; and a connection set-up signal reception determination unit that determines, according to the reception timing, whether the connection set-up signal is received, and performs a signal reception operation based on the determination. According to a corresponding aspect, the connection set-up signal reception determination unit determines whether the connection set-up signal is received or not based on an identifier that is either an identifier indicating the connection set-up signal or a temporary identifier.

According to another aspect of the present invention, there is provided a wireless access network device for bi-directional communications with a mobile station, comprising: a connection set-up signal scheduling unit that, after receiving a connection request signal from the mobile station, performs a connection set-up signal

transmission assignment based on a reception timing of the connection request signal;

a connection set-up signal generation unit that generates a connection set-up signal to be sent to the mobile station; and

a connection set-up signal transmission unit that transmits the connection set-up signal based on the connection set-up signal transmission assignment.

According to still another aspect of the present invention, there is provided a mobile communication system that performs bi-directional communications between a mobile station and a wireless access network device,

wherein

the mobile station includes:

a connection set-up signal reception timing calculation unit that calculates a reception timing of a connection set-up signal when a connection request signal is transmitted; and

a connection set-up signal reception determination unit that determines, according to the reception timing, whether the connection set-up signal is received, and performs a signal reception operation based on the determination; and

the wireless access network device includes:

a connection set-up signal scheduling unit that, after receiving a connection request signal from the mobile station, performs a connection set-up signal transmission assignment based on a reception timing of the connection request signal;

a connection set-up signal generation unit that generates a connection set-up signal to be sent to the mobile station; and

a connection set-up signal transmission unit that transmits the connection set-up signal based on the connection set-up signal transmission assignment.

According to yet another aspect of the present invention, there is provided a mobile communication method

for bi-directional communications between a mobile station and a wireless access network device, comprising:

a connection request signal transmission step for transmitting a connection request signal from the mobile station;

a connection set-up signal reception timing calculation step for calculating, by the mobile station, a reception timing of a connection set-up signal;

a connection request signal reception step for receiving, by the wireless access network device, the connection request signal from the mobile station;

a connection set-up signal scheduling unit step for performing, by the wireless access network device, a connection set-up signal transmission assignment based on a reception timing of the connection request signal;

a connection set-up signal generation step for generating, by the wireless access network device, a connection set-up signal to be sent to the mobile station;

a connection set-up signal transmission step for transmitting, by the wireless access network device, the connection set-up signal based on the connection set-up signal transmission assignment;

a connection set-up signal determination step for determining, according to the reception timing, whether the connection set-up signal is received; and

a connection set-up signal reception step for performing a signal reception operation based on the determination.

ADVANTAGES OF THE INVENTION

According to the present invention, it is possible to provide a mobile station, a wireless access network device, a mobile communication system, and a communication method able to reduce a connection delay, and lower the power consumption.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sequence diagram exemplifying a sequence of setting up a connection between a mobile station and a wireless access network device when the connection request is made from the side of the mobile station;

FIG. 2 is a diagram illustrating a mobile communication system according to an embodiment of the present invention;

FIG. 3 is a block diagram illustrating a configuration of the wireless access network device 100 according to the embodiment of the present invention;

FIG. 4 is a block diagram illustrating a configuration of the wireless access network device 100 according to the embodiment of the present invention;

FIG. 5 is a block diagram illustrating a configuration of the mobile station 200 according to the embodiment of the present invention;

FIG. 6 is a flowchart illustrating operations of the wireless access network device 100 according to the embodiment of the present invention;

FIG. 7 is a sequence diagram illustrating operations of the mobile communication system according to the embodiment of the present invention; and

FIG. 8 is a flowchart illustrating operations of the mobile station according to the embodiment of the present invention.

PREFERRED EMBODIMENTS FOR CARRYING OUT THE INVENTION

Below, embodiments of the present invention are explained with reference to the accompanying drawings, in which the same reference numbers are assigned to elements having the same functions, and overlapping descriptions are omitted.

FIG. 2 is a diagram illustrating a mobile communication system according to an embodiment of the present invention.

The mobile communication system of the present

embodiment includes a mobile station 200 and a wireless access network device 100, and the mobile station 200 and the wireless access network device 100 are able to perform wireless communication with each other.

Note that in the specification and claims of the present application, the wireless access network device 100 may be a wireless base station, a wireless control device, or a device including the wireless base station and the wireless control device.

In the mobile communication system of the present embodiment, transmission timing control is performed, in which a time period from reception of a radio resource control (RRC) connection request signal to transmission of a radio resource control (RRC) connection set-up signal is fixed. Due to this, it is possible to reduce a connection delay and lower the battery power consumption.

Next, the wireless access network device 100 is explained with reference to FIG. 3.

The wireless access network device 100 includes a data transmission and reception unit 102, a connection request signal reception determination unit 104, a connection set-up signal generation unit 110, a connection set-up signal scheduling unit 106, and an identifier designation unit 108. The connection request signal reception determination unit 104 and the connection set-up signal generation unit 110 are connected to the data transmission and reception unit 102; the connection set-up signal scheduling unit 106 and the identifier designation unit 108 are connected to the connection request signal reception determination unit 104 and the connection set-up signal generation unit 110.

The data transmission and reception unit 102 performs reception of the RRC connection request signal from the mobile station, and transmission of the RRC connection set-up signal.

The connection request signal reception

determination unit 104 determines whether the RRC connection request signal is received. When the RRC connection request signal is received, the connection request signal reception determination unit 104 inputs information indicating reception of the RRC connection request signal into the connection set-up signal scheduling unit 106 and the identifier designation unit 108.

The connection set-up signal scheduling unit 106 determines transmission timing of the RRC connection set-up signal based on the reception timing of the RRC connection request signal, and inputs information indicating the determined transmission timing into the connection set-up signal generation unit 110. For example, the connection set-up signal scheduling unit 106 sets the period from the time the RRC connection request signal is received from the mobile station to the time the RRC connection set-up signal is transmitted to be a fixed value Tsetup in advance, and determines the transmission timing based on the fixed value Tsetup. The connection set-up signal scheduling unit 106 may determine the fixed value Tsetup based on the maximum of possible transmission timings of the RRC connection set-up signal.

The identifier designation unit 108 designates an identifier and inputs the identifier into the connection set-up signal generation unit 110. The connection set-up signal generation unit 110 appends the identifier to the RRC connection set-up signal. The mobile station which transmitted the RRC connection request signal can determine whether a RRC connection set-up signal is from itself based on the identifier appended to the RRC connection set-up signal, which corresponds to the RRC connection request signal.

For example, the identifier designation unit 108 designates at least one of an identifier between the mobile station 200 and a node of a rank higher than the wireless access network device 100, namely, between the

mobile station 200 and a core network, an identifier indicating the RRC connection set-up signal, a temporary identifier selected by the mobile station when transmitting the RRC connection request signal, and an identifier indicating a cell.

The connection set-up signal generation unit 110 generates the RRC connection set-up signal and inputs the generated RRC connection set-up signal to the data transmission and reception unit 102. For example, the connection set-up signal generation unit 110 appends the identifier designated in the identifier designation unit 108 to generate the RRC connection set-up signal.

In the present embodiment, as shown in FIG. 4, the connection set-up signal generation unit 110 may be realized by a wireless controller 120 and a wireless base station 130. In this case, for example, the connection request signal reception determination unit 104 and the connection set-up signal generation unit 110 are arranged in the wireless controller 120, and the data transmission and reception unit 102 and the connection set-up signal scheduling unit 106 are arranged in the wireless base station 130. In addition, depending on the type of the identifier to be designated, the identifier designation unit 108 may be arranged in either the wireless controller 120 or the wireless base station 130. For example, when the identifier between the mobile station 200 and a higher rank node of the wireless access network device 100, or the identifier indicating the RRC connection set-up signal is designated, the identifier designation unit 108 is arranged in the wireless controller 120; when the temporary identifier selected by the mobile station when transmitting the RRC connection request signal, or the identifier indicating a cell is designated, the identifier designation unit 108 is arranged in the wireless base station 130.

Next, the mobile station 200 is explained with reference to FIG. 5.

The mobile station 200 includes a data transmission and reception unit 202, a connection request signal transmission unit 204, a connection set-up signal reception determination unit 208, a connection request signal re-transmission timing determination unit 206, and a connection set-up signal reception timing calculation unit 210.

The connection request signal transmission unit 204 and the connection set-up signal reception determination unit 208 are connected to the data transmission and reception unit 202.

The connection request signal re-transmission timing determination unit 206 and the connection set-up signal reception timing calculation unit 210 are connected to the connection request signal transmission unit 204 and the connection set-up signal reception determination unit 208.

The data transmission and reception unit 202 performs transmission of the RRC connection request signal and reception of the RRC connection set-up signal.

The connection request signal transmission unit 204 performs transmission of the RRC connection request signal. The mobile station 200 transmits the RRC connection request signal from the data transmission and reception unit 202.

The connection set-up signal reception timing calculation unit 210 calculates reception timing of the RRC connection set-up signal based on the transmission timing of the RRC connection request signal, and inputs the calculation results into the connection set-up signal reception determination unit 208. For example, the connection set-up signal reception timing calculation unit 210 sets the period from the time the RRC connection request signal is received from the mobile station to the time the RRC connection set-up signal is transmitted to be a fixed value Tsetup in advance, and determines the reception timing based on the fixed value Tsetup. Further,

the connection set-up signal reception timing calculation unit 210 may use the maximum of possible reception timings of the RRC connection set-up signal as the fixed value Tsetup, and input the fixed value Tsetup into the connection set-up signal reception determination unit 208.

The connection set-up signal reception determination unit 208 determines whether the RRC connection set-up signal is received. When it is detected that the RRC connection set-up signal is received, the connection set-up signal reception determination unit 208 inputs a command to the data transmission and reception unit 202 to start transmission of uplink data. As a result, transmission of uplink data is started. On the other hand, when reception of the RRC connection set-up signal is not detected, the connection set-up signal reception determination unit 208 inputs information indicating that the RRC connection set-up signal is not received into the connection request signal re-transmission timing determination unit 206.

The connection request signal re-transmission timing determination unit 206 determines the timing of re-transmitting the RRC connection request signal. Further, the connection request signal re-transmission timing determination unit 206 inputs information indicating the determined re-transmission timing of the RRC connection request signal into the connection request signal transmission unit 204. As a result, the RRC connection request signal is re-transmitted.

Next, operations of the mobile communication system of the present embodiment are described.

First, operations of the wireless access network device 100 of the present embodiment are described with reference to FIG. 6.

The connection request signal reception determination unit 104 determines whether the connection request signal is received (step S602).

When the RRC connection request signal is

received (step S602, YES), the connection set-up signal scheduling unit 106 determines, at predetermined timings, the transmission timing of the RRC connection set-up signal based on the reception timing of the RRC connection request signal (step S604).

For example, as shown in FIG. 7, the connection set-up signal scheduling unit 106 sets the period from the time the RRC connection request signal is received from the mobile station to the time the RRC connection set-up signal is transmitted to be the fixed value Tsetup in advance, and determines the transmission timing based on the fixed value Tsetup. The connection set-up signal scheduling unit 106 may use the maximum of possible transmission timings of the RRC connection set-up signal as the fixed value Tsetup.

On the other hand, when the RRC connection request signal is not received (step S602, NO), the routine proceeds to step S602.

Next, the identifier designation unit 108 designates an identifier of the RRC connection set-up signal (step S606). For example, the identifier designation unit 108 assigns at least one of the identifier between the mobile station 200 and the core network, the identifier indicating the RRC connection set-up signal, the temporary identifier selected by the mobile station when transmitting the RRC connection request signal, and the identifier indicating a cell.

Next, the connection set-up signal generation unit 110 generates the RRC connection set-up signal based on the identifier assigned by the identifier designation unit 108 (step S608). For example, the connection set-up signal generation unit 110 appends the identifier designated in the identifier designation unit 108 to generate the RRC connection set-up signal.

Next, the data transmission and reception unit 102 transmits the connection set-up signal generated in the connection set-up signal generation unit 110 at

timings determined in the connection set-up signal scheduling unit 106. For example, the data transmission and reception unit 102 may use the channel for transmitting the RRC connection set-up signal as the common channel, and may transmit part of the identifier through a signaling control channel. In doing so, it is not necessary to perform channel switching during connection set-up.

Next, operations of the mobile station 200 of the present embodiment are described with reference to FIG. 8.

First, the connection request signal transmission unit 204 determines whether the RRC connection set-up signal is received (step S802).

When the RRC connection set-up signal is received, the connection set-up signal reception timing calculation unit 210 calculates the reception timing of the RRC connection set-up signal based on the transmission timing of the RRC connection request signal. The connection set-up signal reception determination unit 208 waits for the RRC connection set-up signal according to the reception timing of the RRC connection set-up signal (step S804). For example, the connection set-up signal reception timing calculation unit 210 adds the above mentioned fixed value Tsetup to the transmission timing of the RRC connection request signal, and uses the obtained result as the reception timing of the RRC connection set-up signal. The connection set-up signal reception determination unit 208 waits for the RRC connection set-up signal at the calculated reception timing of the RRC connection set-up signal.

The connection set-up signal reception determination unit 208 may continue to receive the RRC connection set-up signal after transmission of the RRC connection request signal until the time period Tsetup elapses. Here, Tsetup may be defined as a specification, or may be transmitted to the mobile station 200 through

system information from the wireless access network device 100.

Next, at the calculated reception timing of the RRC connection set-up signal, the connection set-up signal reception determination unit 208 determines whether a RRC connection set-up signal sent to the connection set-up signal reception determination unit 208 itself is received (step S806). Here, the connection set-up signal reception determination unit 208 determines whether the RRC connection set-up signal sent to itself is received based on the identifier.

When it is determined that the RRC connection set-up signal is sent to the connection set-up signal reception determination unit 208 itself (step S806, YES), the mobile station 200 starts uplink transmission based on connection information specified by the connection set-up signal (step S808).

When the RRC connection set-up signal sent to the connection set-up signal reception determination unit 208 itself is not received (step S806, NO), the connection request signal re-transmission timing determination unit 206 re-transmits the RRC connection request signal at the re-transmission timings specified by the wireless access network device 100 in advance until the maximum re-transmission times (step S810).

In the above embodiment, it is described that the mobile station requests the wireless access network device for connection. It should be noted that the present invention is applicable when the wireless access network device makes the connection request to the mobile station.

As described above, in the present embodiment, transmission assignment of the RRC connection set-up signal is performed after a fixed time period elapses from the time the RRC connection request signal is received. Due to this, the mobile station performs signal reception operations at known reception timings, and the mobile station can perform determination operations at a high

speed, namely, continue communications when a signal sent to the mobile station itself is received, and re-transmit signals when the signal sent to the mobile station itself is not received.

In addition, since the reception timings of the RRC connection set-up signal are known, and the mobile station performs signal reception operations of the RRC connection set-up signal only at these known reception timings, it is possible to lower the power consumption of the battery.

In addition, since it is possible to quickly determine whether it is necessary to re-transmit the RRC connection request signal according to whether the signal sent to the mobile station itself is present or not at the reception timings, it is possible to reduce the connection delay.

Further, since the RRC connection set-up signal is transmitted through the common channel, it is not necessary to perform channel switching from the common channel to the dedicated physical channel, and it is possible to reduce the time required for setting up the dedicated physical channel and synchronization of the dedicated physical channel, and reduce the workload.

While the invention has been described with reference to preferred embodiments, the invention is not limited to these embodiments, but numerous modifications could be made thereto without departing from the basic concept and scope described in the claims.

INDUSTRY APPLICABILITY

The present invention is applicable to a mobile station and a wireless access network device in a mobile communication system, and the mobile communication system itself.

This international application is based on Japanese Priority Patent Application No. 2005-217578 filed on July 27, 2005, the entire contents of which are hereby

incorporated by reference.

CLAIMS

1. A mobile station for bi-directional communications with a wireless access network device, comprising:

a connection set-up signal reception timing calculation unit that calculates a reception timing of a connection set-up signal when a connection request signal is transmitted; and

a connection set-up signal reception determination unit that determines, according to the reception timing, whether the connection set-up signal is received, and performs a signal reception operation based on the determination, wherein

the connection set-up signal reception determination unit determines whether the connection set-up signal is received or not based on an identifier that is either an identifier indicating the connection set-up signal or a temporary identifier.