

Exhibit 1010



Certification of Accuracy of Translation

Sun IP Project # 23-736

Japanese to English translation of JP2006033778A

I, Eric Vance, hereby certify that I am fluent in both the Japanese and English languages and that the attached English translation is, to the best of my knowledge, a true and accurate translation of JP2006033778A. The translated text reflects the content, meaning and style of the original text and constitutes a true and accurate translation of the original document. I have been warned that willful false statements and the like are punishable by fine or imprisonment, or both under 18 U.S.C. 1001.

February 21, 2023

A handwritten signature in black ink, appearing to read "Eric Vance", written over a horizontal line.

Eric Vance



Certification of Accuracy of Translation

Sun IP Project # 23-736

Japanese to English translation of JP2006033778A

I, Jacob Lee, hereby certify that I am fluent in both the Japanese and English languages and that the attached English translation is, to the best of my knowledge, a true and accurate translation of JP2006033778A. The translated text reflects the content, meaning and style of the original text and constitutes a true and accurate translation of the original document. I have been warned that willful false statements and the like are punishable by fine or imprisonment, or both under 18 U.S.C. 1001.

Feb. 21, 2023

A handwritten signature in cursive script that reads "Jacob Lee". The signature is written in black ink and is positioned above a horizontal line.

Jacob Lee

Translator Comments:

- 図 9 in line 29, page 4, appears to be a typo of 図 2 2 . The translation retains this potential typo as “FIG. 9”.
- 移動局 1 0 in line 8, page 13, appears to be a typo of 移動局 2 0 a . The translation retains this potential typo as “the mobile station 10”.

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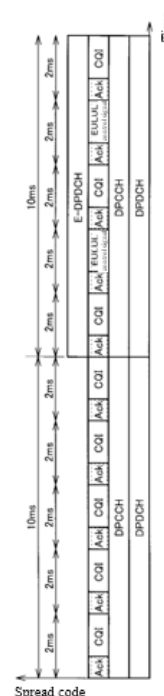
(54) [Title of Invention] Mobile Station, Base Station, Control Device, Mobile Communication System, and Mobile Communication Method

(57) [Abstract]

[Problem] To transmit an enhanced uplink physical control signal conforming to enhanced access without affecting existing physical channels or increasing a peak-to-average ratio in transmission power of a mobile station.

[Resolution Means] A high-speed uplink physical control signal on an uplink physical control channel conforming to high-speed packet access (HS-DPCCH) and an EPLUL control signal conforming to enhanced access are transmitted from a mobile station to a base station by time-division multiplexing.

[Selected FIG.] FIG. 4



[Scope of Patent Claims]

[Claim 1]

A mobile station, comprising:

a radio unit that performs radio transmission and reception with a base station; and

a radio control unit that controls the radio unit so an enhanced uplink physical control signal conforming to enhanced access and a high-speed uplink physical control signal on a high-speed uplink physical control channel conforming to high-speed packet access are transmitted by time-division multiplexing.

[Claim 2]

10 The mobile station of claim 1, wherein the radio control unit controls the radio unit so the enhanced uplink physical control signal is transmitted in a quality time slot that transmits a channel quality indicator included in the high-speed uplink physical control channel.

[Claim 3]

The mobile station of claim 1 or 2, wherein the radio control unit controls the radio unit so the enhanced uplink physical control signal is transmitted at a timing known in the base station.

[Claim 4]

The mobile station of claim 1 or 2, further comprising: a transmission notification unit that notifies the base station of transmission of the enhanced uplink physical control signal; 20 wherein

the radio control unit controls the radio unit so the enhanced uplink physical control signal is transmitted according to the notification.

[Claim 5]

The mobile station of claim 4, wherein the transmission notification unit performs the notification by transmitting at least one among a notification signal set to a value not used for control in high-speed packet access, a notification signal spread by a spread code different from a spread code used for a signal on the high-speed uplink physical control channel, and a notification signal of a different transmission power than a signal on the high-speed uplink physical control channel.

30 [Claim 6]

The mobile station of claim 5, wherein the radio control unit controls the transmission power of the notification signal.

[Claim 7]

The mobile station of any one among claims 1 to 6, wherein the radio control unit controls a transmission power of transmitting the enhanced uplink control physical signal.

[Claim 8]

A base station, comprising:

a radio unit that receives an enhanced uplink physical control signal conforming to enhanced access transmitted by time-division multiplexing with a high-speed uplink physical control signal on a high-speed uplink physical control channel conforming to high-speed packet access; and 40

a detection unit that detects the enhanced uplink physical control signal from the high-speed uplink physical control signal and enhanced uplink physical control signal subjected to time-division multiplexing.

[Claim 9]

The base station of claim 8, wherein the detection unit detects the enhanced uplink physical control signal transmitted in a quality time slot that transmits a channel quality indicator included in the high-speed uplink physical control channel.

[Claim 10]

The base station of claim 8 or 9, wherein the detection unit detects the enhanced uplink physical control signal, transmitted at a timing known in the base station from the mobile station, at the known timing.

[Claim 11]

10 The base station of claim 8 or 9, wherein the detection unit detects the enhanced uplink physical control signal based on a notification of transmission of the enhanced uplink physical control signal from the mobile station.

[Claim 12]

The base station of claim 11, wherein the detection unit detects the enhanced uplink physical control signal based on at least one among a notification signal set to a value not used for control in high-speed packet access, a notification signal spread by a spread code different from a spread code used for a signal on the high-speed uplink physical control channel, and a notification signal of a different transmission power than a signal on the high-speed uplink physical control channel.

[Claim 13]

20 The base station of claim 11 or 12, wherein the detection unit determines a reliability of the notification and detects the enhanced uplink physical control signal based on a result of the determination.

[Claim 14]

A control device, comprising:

a setting unit that, in a mobile station transmitting an enhanced uplink physical control signal conforming to enhanced access and a high-speed uplink physical control signal on a high-speed uplink physical control channel conforming to high-speed packet access to a base station by time-division multiplexing, sets a timing of transmitting the enhanced uplink physical control signal; and

30 a setting-content notification unit that notifies the mobile station and the base station of the timing set by the setting unit.

[Claim 15]

The control device of claim 14, wherein the setting unit, in the mobile station transmitting the enhanced uplink physical control signal, sets which to perform among a first transmission method of transmitting the enhanced uplink physical control signal at a timing known in the base station and a second transmission method of notifying, from the mobile station to the base station, transmission of the enhanced uplink physical control signal and transmitting the enhanced uplink physical control signal according to the notification, and

40 the setting-content notification unit notifies the mobile station of either among the first transmission method and the second transmission method set by the setting unit.

[Claim 16]

The control device of claim 15, wherein the setting unit sets a notification-signal transmission power value of a notification signal used for the notification, and

the setting-content notification unit notifies the mobile station of the notification-signal transmission power value set by the setting unit.

[Claim 17]

The control device of claim 15 or 16, wherein the setting unit sets a reliability threshold of the notification, and

the setting-content notification unit notifies the base station of the reliability threshold set by the setting unit.

[Claim 18]

The control device of any one among claims 14 to 17, wherein the setting unit sets a control-signal transmission power value whereat the enhanced uplink control physical signal is transmitted, and

10 the setting-content notification unit notifies the mobile station of the control-signal transmission power value set by the setting unit.

[Claim 19]

A mobile communication system, comprising:

a mobile station that transmits an enhanced uplink physical control signal conforming to enhanced access and a high-speed uplink physical control signal on a high-speed uplink physical control channel conforming to high-speed packet access by time-division multiplexing; and

a base station that detects the enhanced uplink physical control signal from the high-speed uplink physical control signal and enhanced uplink physical control signal subjected to time-division multiplexing.

[Claim 20]

20 A mobile communication method, comprising: transmitting an enhanced uplink physical control signal conforming to enhanced access and a high-speed uplink physical control signal on a high-speed uplink physical control channel conforming to high-speed packet access from a mobile station to a base station by time-division multiplexing.

[Detailed Description of Invention]

[Field of Art]

[0001]

The present invention relates to a mobile station, a base station, a control device, a mobile communication system, and a mobile communication method.

[Background Art]

30 [0002]

W-CDMA (Wideband Code-Division Multiple Access) is a radio access method in third-generation mobile communication systems being standardized by the international standards body 3GPP (3rd Generation Partnership Project). As illustrated in FIG. 21, W-CDMA uplink physical channels whose specifications are already determined include: a dedicated physical data channel (DPDCH: dedicated physical data channel) that transmits user data, a dedicated physical control channel (DPCCH: dedicated physical control channel) ancillary to the dedicated physical data channel, and a dedicated physical control channel conforming to high-speed downlink packet access (HSDPA: high-speed downlink packet access) (HS-DPCCH: high-speed DPCCH). A mobile station performs transmission using frames of a length of 10 ms for DPDCH and

40 DPCCH and frames of a length of 2 ms for HS-DPCCH. At this time, the mobile station subjects DPDCH, DPCCH, and HS-DPCCH to code-division multiplexing.

[0003]

Furthermore, 3GPP is considering enhanced uplink (enhanced uplink) to improve uplink transmission efficiency. In enhanced uplink, as a new physical channel, a dedicated physical data channel that performs enhanced transmission of user data (E-DPDCH: enhanced DPDCH) is transmitted. Moreover, an enhanced uplink physical control signal (UL control signal)

conforming to enhanced uplink (EUL: enhanced uplink) is transmitted. Hereinbelow, an enhanced uplink physical control signal conforming to enhanced access is referred to as an “EULUL control signal”.

[0004]

For E-DPDCH, it is determined that transmission is performed by code-division multiplexing with the existing uplink physical channels. However, no such determination is made regarding an EULUL control signal. As a transmission method of an EULUL control signal, the three methods illustrated in FIG. 9 are currently proposed (for example, see non-

10 [0005]

As illustrated in (a) in FIG. 22, the first method is a method of transmitting an EULUL control signal on DPDCH by multiplexing with other transport channels transmitted in DPDCH. At this time, a quality of the EULUL control signal is adjusted by rate matching attributes (rate matching attributes).

[0006]

As illustrated in (b) in FIG. 22, the second method is a method of transmitting an EULUL control signal on DPCCH by sharing DPCCH radio physical symbols with other physical control signals transmitted in DPCCH.

[0007]

20 As illustrated in (c) in FIG. 22, the third method is a method of transmitting by assigning a dedicated spread code to an EULUL control signal and subjecting the EULUL control signal to code-division multiplexing with the other uplink physical channels.

[Non-Patent Literature 1] 3GPP TR 25.896 V6.0.0 (2004-03)

[Disclosure of Invention]

[Problem to Be Solved by Invention]

[0008]

30 However, in the first method and the second method, which cram the EULUL control signal in DPDCH and DPCCH, transmitting the EULUL control signal strains DPDCH and DPCCH radio resources. As such, when a signal amount of the EULUL control signal increases, the existing physical channels are affected, inviting transmission quality degradation and the like.

[0009]

Meanwhile, in the third method, the EULUL control signal is transmitted using a physical channel of a different spread code than the other uplink physical channels. This does not strain the radio resources of the other physical channels. However, there is a concern that increasing a number of multiplexed spread codes will increase a peak-to-average ratio (PAR: peak-to-average ratio) in transmission power of the mobile station.

[0010]

40 Therefore, the present invention has as an object to transmit an enhanced uplink physical control signal conforming to enhanced access without affecting existing physical channels or increasing a peak-to-average ratio in transmission power of a mobile station.

[Means for Solving Problem]

[0011]

A mobile station of the present invention is provided with: a radio unit that performs radio transmission and reception with a base station; and a radio control unit that controls the radio unit so an enhanced uplink physical control signal conforming to enhanced access and a

high-speed uplink physical control signal on a high-speed uplink physical control channel conforming to high-speed packet access are transmitted by time-division multiplexing.
[0012]

By transmitting the enhanced uplink physical control signal and the high-speed uplink physical control signal by time-division multiplexing, a transmission quality of a physical channel conforming to high-speed packet access is hardly affected. Moreover, because time-division multiplexing is performed, an increased code-division multiplexing count of simultaneously transmitted signals can be prevented. As such, an increased peak-to-average ratio in transmission power of the mobile station can be prevented.

10 [0013]

Therefore, this mobile station can transmit the enhanced uplink physical control signal conforming to enhanced access without affecting existing physical channels or increasing the peak-to-average ratio in the transmission power of the mobile station.

[0014]

Preferably, the radio control unit controls the radio unit so the enhanced uplink physical control signal is transmitted in a quality time slot that transmits a channel quality indicator included in an uplink physical control channel conforming to enhanced high-speed packet access. The channel quality indicator is used to control downlink data transmission conforming to high-speed packet access. Suppressing a transmission frequency of this channel quality indicator hardly affects a data transmission throughput. As such, the mobile station can prevent transmission quality degradation of existing physical channels.

20

[0015]

Preferably, the radio control unit controls the radio unit so the enhanced uplink physical control signal is transmitted at a timing known in the base station. This enables the base station to distinguish the enhanced uplink physical control signal from among the signals subjected to time-division multiplexing.

[0016]

Furthermore, the mobile station may be further provided with: a transmission notification unit that notifies the base station of transmission of the enhanced uplink physical control signal; wherein the radio control unit controls the radio unit so the enhanced uplink physical control signal is transmitted according to the notification. This enables the base station to distinguish the enhanced uplink physical control signal, from among the signals subjected to time-division multiplexing, based on the notification from the mobile station.

30

[0017]

The transmission notification unit can perform the notification by transmitting at least one among a notification signal set to a value not used for control in high-speed packet access, a notification signal spread by a spread code different from a spread code used for a signal on the high-speed uplink physical control channel, and a notification signal of a different transmission power than a signal on the high-speed uplink physical control channel.

40

[0018]

Preferably, the radio control unit controls the transmission power of the notification signal. Moreover, preferably, the radio control unit controls a transmission power of transmitting the enhanced uplink physical control signal. Accordingly, the mobile station can meet required qualities of the notification signal and the uplink physical control signal by controlling the transmission power.

[0019]

A base station of the present invention is provided with: a radio unit that receives an enhanced uplink physical control signal conforming to enhanced access transmitted by time-division multiplexing with a high-speed uplink physical control signal on a high-speed uplink physical control channel conforming to high-speed packet access; and a detection unit that detects the enhanced uplink physical control signal from the high-speed uplink physical control signal and enhanced uplink physical control signal subjected to time-division multiplexing.
[0020]

10 According to this base station, even when an enhanced uplink physical control signal conforming to enhanced access transmitted by time-division multiplexing with a high-speed uplink physical control signal on a high-speed uplink physical control channel is received, the enhanced uplink physical control signal can be detected from the high-speed uplink physical control signal and enhanced uplink physical control signal subjected to time-division multiplexing. Therefore, the mobile station can transmit the enhanced uplink physical control signal by the above method that does not affect existing physical channels or increase a peak-to-average ratio in transmission power of the mobile station.
[0021]

20 Preferably, the detection unit detects the enhanced uplink physical control signal transmitted in a quality time slot that transmits a channel quality indicator included in the high-speed uplink physical control channel. Accordingly, even when the enhanced uplink physical control signal is transmitted in a quality time slot, the base station can detect the enhanced uplink physical control signal from the high-speed uplink physical control signal and enhanced uplink physical control signal subjected to time-division multiplexing. Therefore, the mobile station can transmit the enhanced uplink physical control signal by a method that can prevent transmission quality degradation of existing physical channels without affecting the existing physical channels or increasing a peak-to-average ratio in transmission power of the mobile station.
[0022]

30 The detection unit can detect the enhanced uplink physical control signal, transmitted at a timing known in the base station from the mobile station, at the known timing. Moreover, the detection unit may detect the enhanced uplink physical control signal based on a notification of transmission of the enhanced uplink physical control signal from the mobile station. This enables the base station to easily distinguish the enhanced uplink physical control signal from among the signals subjected to time-division multiplexing.
[0023]

The detection unit can detect the enhanced uplink physical control signal based on at least one among a notification signal set to a value not used for control in high-speed packet access, a notification signal spread by a spread code different from a spread code used for a signal on the high-speed uplink physical control channel, and a notification signal of a different transmission power than a signal on the high-speed uplink physical control channel.
[0024]

40 Preferably, the detection unit determines a reliability of the notification and detects the enhanced uplink physical control signal based on a result of this determination. This enables the base station to more appropriately detect the enhanced uplink physical control signal.
[0025]

A control device of the present invention is provided with: a setting unit that, in a mobile station transmitting an enhanced uplink physical control signal conforming to enhanced access and a high-speed uplink physical control signal on a high-speed uplink physical control channel

conforming to high-speed packet access to a base station by time-division multiplexing, sets a timing of transmitting the enhanced uplink physical control signal; and a setting-content notification unit that notifies the mobile station and the base station of the timing set by the setting unit.

[0026]

According to this control device, even when the mobile station transmits the enhanced uplink physical control signal and the high-speed uplink physical control signal by time-division multiplexing, the mobile station can transmit the enhanced uplink physical control signal so the base station can detect the enhanced uplink physical control signal from the high-speed uplink physical control signal and enhanced uplink physical control signal subjected to time-division multiplexing. Therefore, the mobile station can transmit the enhanced uplink physical control signal by the above method that does not affect existing physical channels or increase a peak-to-average ratio in transmission power of the mobile station.

[0027]

Furthermore, the setting unit, in the mobile station transmitting the enhanced uplink physical control signal, can set which to perform among a first transmission method of transmitting the enhanced uplink physical control signal at a timing known in the base station and a second transmission method of notifying, from the mobile station to the base station, transmission of the enhanced uplink physical control signal and transmitting the enhanced uplink physical control signal according to this notification. In this situation, the setting-content notification unit notifies the mobile station of either among the first transmission method and the second transmission method set by the setting unit. Accordingly, the control device can cause the mobile station to choose between using the first transmission method and the second transmission method as necessary.

[0028]

Furthermore, preferably, the setting unit sets a notification-signal transmission power value of a notification signal used for the notification, and the setting-content notification unit notifies the mobile station of the notification-signal transmission power value set by the setting unit. Moreover, the setting unit can set a control-signal transmission power value whereat the enhanced uplink control physical signal is transmitted, and the setting-content notification unit can notify the mobile station of the control-signal transmission power value set by the setting unit. Moreover, the setting unit can set a reliability threshold of the notification, and the setting-content notification unit can notify the base station of the reliability threshold set by the setting unit. Accordingly, the control device can appropriately control transmission of the enhanced uplink physical control signal by the mobile station and detection of the enhanced uplink physical control signal by the base station.

[0029]

A mobile communication system of the present invention is provided with: a mobile station that transmits an enhanced uplink physical control signal conforming to enhanced access and a high-speed uplink physical control signal on a high-speed uplink physical control channel conforming to high-speed packet access by time-division multiplexing; and a base station that detects the enhanced uplink physical control signal from the high-speed uplink physical control signal and enhanced uplink physical control signal subjected to time-division multiplexing.

[0030]

A mobile communication method of the present invention transmits an enhanced uplink physical control signal conforming to enhanced access and a high-speed uplink physical control

signal on a high-speed uplink physical control channel conforming to high-speed packet access from a mobile station to a base station by time-division multiplexing.

[Effects of Invention]

[0031]

As described above, the present invention can transmit an enhanced uplink physical control signal conforming to enhanced access without affecting existing physical channels or increasing a peak-to-average ratio in transmission power of a mobile station.

[Preferred Embodiments of Invention]

[0032]

10 (Mobile Communication System)

As illustrated in FIG. 1, a mobile communication system 100 is provided with a base station 10, mobile stations 20a to 20c, and a radio control device 30. The radio control device 30 controls radio communication between the base station 10 and the mobile stations 20a to 20c. A radio link is established between the base station 10 and the mobile stations 20a to 20c. The radio link includes an uplink 1 transmitted from the mobile stations 20a to 20c to the base station 10 and a downlink 2 transmitted from the base station 10 to the mobile stations 20a to 20c. Specifically, the mobile stations 20a to 20c and the base station 10 transmit physical channels as illustrated in FIG. 2.

[0033]

20 The mobile stations 20a to 20c and the base station 10 transmit user data by using dedicated physical channels dedicated to each mobile station. In uplink, the mobile stations 20a to 20c can transmit user data by using at least one among an uplink DPDCH/DPCCH 1b and an E-DPDCH / EULUL control signal 1a. The uplink DPDCH/DPCCH 1b, the E-DPDCH / EULUL control signal 1a, and an HS-DPCCH 1c are uplink physical channels.

[0034]

The uplink DPDCH/DPCCH 1b is a dedicated physical data channel (DPDCH: dedicated physical data channel) that transmits user data and a dedicated physical control channel (DPCCH: dedicated physical control channel) ancillary to this dedicated physical data channel.

[0035]

30 The E-DPDCH / EULUL control signal 1a is a dedicated physical data channel that performs enhanced transmission of user data according to enhanced uplink (enhanced uplink) (E-DPDCH: enhanced DPDCH) and an EULUL control signal. The EULUL control signal is an enhanced uplink physical control signal (UL control signal) conforming to enhanced uplink (EUL: enhanced uplink).

[0036]

The HS-DPCCH 1c is a dedicated physical control channel conforming to high-speed downlink packet access (HSDPA: high-speed downlink packet access) (high-speed DPCCH). That is, HS-DPCCH is a high-speed uplink physical control channel conforming to high-speed packet access. Moreover, a high-speed uplink physical control signal is transmitted on the high-speed uplink physical control channel.

40 [0037]

In downlink, the base station 10 can transmit user data by using at least one among a downlink DPDCH/DPCCH 2b and an HS-DSCH 2c. The downlink DPDCH/DPCCH 2b, a downlink E-DPCCH 2a, and the HS-DSCH 2c are downlink physical channels.

[0038]

The HS-DSCH 2c is a shared physical data channel that performs high-speed transmission of user data according to high-speed downlink packet access (HSDPA) (HS downlink shared channel). In FIG. 2, the HS-DSCH 2c, which is not assigned to the mobile stations 20a, 20c at this point, is illustrated as a dotted line. The mobile station 20b, whereto the HS-DSCH 2c is assigned, transmits downlink user data by using mainly the HS-DSCH 2c. [0039]

10 In such physical channel transmission between the mobile stations 20a to 20c and the base station 10, in the mobile communication system 100, an enhanced uplink physical control signal conforming to enhanced access and a high-speed uplink physical control signal on a high-speed uplink physical control channel conforming to high-speed packet access are transmitted from the mobile stations 20a to 20c to the base station 10 by time-division multiplexing.

[0040]

The uplink transmission of the plurality of physical channels is detailed using FIG. 3 to FIG. 5. In FIG. 3 to FIG. 5, the horizontal axis indicates time, and the vertical axis indicates spread code. FIG. 3 illustrates a frame format and code-division multiplexing configuration of the uplink physical channels of when no E-DPDCH / EULUL control signal conforming to enhanced uplink (enhanced uplink) is transmitted. Frame lengths of DPDCH and DPCCH are 10 ms.

[0041]

20 HS-DPCCH is configured by time-division multiplexing of an HS-DPCCH subframe 3 whose subframe length is 2 ms. In HS-DPCCH, the HS-DPCCH subframe 3 is repeatedly transmitted. DPDCH, DPCCH, and HS-DPCCH are subjected to code-division multiplexing using three different spread codes and transmitted simultaneously.

[0042]

30 The HS-DPCCH subframe 3 includes an acknowledgment (Ack: acknowledgment) and a channel quality indicator (CQI: channel quality indicator). Specifically, the HS-DPCCH subframe 3 includes one time slot that transmits an acknowledgment (Ack) and two quality time slots that transmit a channel quality indicator (CQI) for a total of three time slots. Hereinbelow, the quality time slot that transmits a channel quality indicator (CQI) is referred to as a “CQI slot”. The acknowledgment (Ack) is transmitted using the first slot of the subframe 3, and the channel quality indicator (CQI) is transmitted using the two slots in the latter half. Because this pattern is fixed, the base station 10 can distinguish between Ack and CQI on HS-DPCCH.

[0043]

The acknowledgment (Ack) is information indicating whether user data transmitted by HS-DSCH in downlink was able to be received normally by the mobile stations 20a to 20c. Acknowledgment is performed on a physical-layer level by each mobile station 20a to 20c. Ack includes HARQ-Ack (hybrid automatic repeat request Ack) and the like.

[0044]

40 The channel quality indicator (CQI) is information regarding a downlink radio quality. The channel quality indicator (CQI) is a downlink radio quality between each mobile station 20a to 20c and the base station 10 and is determined in each mobile station 20a to 20c. The channel quality indicator (CQI) is used to control downlink data transmission conforming to high-speed packet access. Specifically, based on the channel quality indicator (CQI), the base station 10 determines a mobile station whereto HS-DSCH is assigned, a transmission rate of data transmission in HS-DSCH, and the like.

[0045]

FIG. 4 and FIG. 5 illustrate a frame format and code-division multiplexing configuration of the uplink physical channels of when an E-DPDCH / EULUL control signal conforming to enhanced uplink (enhanced uplink) is transmitted. FIG. 4 and FIG. 5 illustrate a time of transitioning from a state wherein no E-DPDCH / EULUL control signal is transmitted to a state wherein such a signal is transmitted. There are two types of E-DPDCH frame lengths: 10 ms and 2 ms. FIG. 4 illustrates a situation wherein the frame length is 10 ms, and FIG. 5 illustrates a situation wherein the frame length is 2 ms.

[0046]

10 The mobile stations 20a to 20c, when transmission of an E-DPDCH / EULUL control signal conforming to enhanced uplink is started, subject DPDCH, DPCCH, HS-DPCCH, and E-DPDCH to code-division multiplexing by using four different spread codes and transmit these simultaneously. When the E-DPDCH frame length is 2 ms, the mobile stations 20a to 20c subject a plurality of E-DPDCH frames to time-division multiplexing.

[0047]

Furthermore, the mobile stations 20a to 20c transmit the EULUL control signal in the CQI slot included in HS-DPCCH. The mobile stations 20a to 20c can transmit the channel quality indicator (CQI) in all frames of HS-DPCCH or transmit such at intervals, in several HS-DPCCH frames. Therefore, the mobile stations 20a to 20c can transmit the EULUL control signal by using the CQI time slot.

20 [0048]

When a need arises to transmit the EULUL control signal, the mobile stations 20a to 20c normally set the EULUL control signal in the CQI slot setting the channel quality indicator (CQI) and transmit HS-DPCCH and the EULUL control signal by time-division multiplexing. That is, when a need arises to transmit the EULUL control signal, the mobile stations 20a to 20c transmit no channel quality indicator (CQI) in HS-DPCCH and perform transmission by replacing the channel quality indicator (CQI) with the EULUL control signal. At this time, in FIG. 4 and FIG. 5, HS-DPCCH and the EULUL control signal are transmitted by physical channels of identical spread codes. However, HS-DPCCH and the EULUL control signal are subjected to time-division multiplexing and have different transmission timings. As such, HS-DPCCH and the EULUL control signal may be transmitted by physical channels of different spread codes.

30

[0049]

A transmission interval of the EULUL control signal and the channel quality indicator (CQI)—that is, a radio resource amount assigned to transmission of the EULUL control signal and the channel quality indicator (CQI)—can be determined according to, for example, a signal amount of the EULUL control signal or downlink radio quality fluctuation conditions. For example, when the signal amount of the EULUL control signal is large or the downlink radio quality is stable and has little fluctuation, a high radio resource amount can be assigned to transmission of the EULUL control signal, the transmission interval of the EULUL control signal can be shortened, and a transmission frequency of the EULUL control signal can be increased.

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[0050]

Meanwhile, when, for example, the signal amount of the EULUL control signal is low or the downlink radio quality is unstable and has high fluctuation, the radio resource amount assigned to transmission of the EULUL control signal can be decreased, the transmission interval of the EULUL control signal can be lengthened, and the transmission frequency of the EULUL control signal can be decreased. Such setting of the transmission interval of the EULUL control

signal and the channel quality indicator (CQI) (setting of radio resource amount assigned to transmission of EULUL control signal and channel quality indicator (CQI)) may be performed by the mobile stations 20a to 20c or the base station 10. Note that the transmission interval of the EULUL control signal and the channel quality indicator (CQI) can also be set in advance by operation.

[0051]

Note that as illustrated in FIG. 4 and FIG. 5, when no E-DPDCH / EULUL control signal is transmitted, the mobile stations 20a to 20c transmit the channel quality indicator (CQI) as normal in HS-DPCCH. Moreover, in FIG. 4 and FIG. 5, E-DPDCH and the EULUL control signal are subjected to code-division multiplexing and transmitted simultaneously. However, E-DPDCH and the EULUL control signal do not need to be transmitted simultaneously.

[0052]

In this manner, in the mobile communication system 100, an enhanced uplink physical control signal conforming to enhanced access (EULUL control signal) is transmitted in a quality time slot that transmits a channel quality indicator included in a high-speed uplink physical control channel conforming to high-speed packet access. The mobile communication system 100 thereby transmits the high-speed uplink physical control signal and the enhanced uplink physical control signal by time-division multiplexing. That is, in the mobile communication system 100, the EULUL control signal and a high-speed uplink physical control signal on HS-DPCCH are transmitted from the mobile stations 20a to 20c to the base station 10 by time-division multiplexing.

[0053]

Here, FIG. 6 illustrates results of evaluating an effect that the transmission interval of the channel quality indicator (CQI) has on downlink data transmission conforming to high-speed packet access. The transmission interval of the channel quality indicator (CQI) was changed to be 1, 2, 4, 5, and 10 (TTI: transmission time interval), and throughputs of data transmission in HS-DSCH at these times were evaluated. In FIG. 6, “X (TTI)” indicates transmitting the channel quality indicator (CQI) at a rate of once per X HS-DPCCH frames. For example, “1 TTI” indicates transmitting the channel quality indicator (CQI) in all HS-DPCCH frames. “10 TTI” indicates transmitting the channel quality indicator (CQI) at a rate of once per ten HS-DPCCH frames.

[0054]

In FIG. 6, the vertical axis indicates throughput (bps), and the horizontal axis indicates I_{or}/I_{oc} (dB). I_{or}/I_{oc} is a variable indicating a distance between the base station and mobile station in communication. The greater the I_{or}/I_{oc} , the closer the mobile station is to the base station it is communicating with. Moreover, the evaluation was performed under conditions of a moving speed of the mobile station of 3 km/h (Vehicular-A) and a transmission power the base station assigns to downlink HS-DSCH being 50% of the transmission power of the base station ($E_c/I_{or} = 50\%$). As evident from FIG. 6, even if the transmission interval of the channel quality indicator (CQI) is increased and the transmission frequency thereof is suppressed, the throughput of data transmission in HS-DSCH is not degraded and is hardly affected.

[0055]

Next, configurations of the mobile stations 20a to 20c, the base station 10, and the radio control device 30 used in such transmission and reception of the physical channels are described. As illustrated in FIG. 7, the mobile station 20a is provided with an antenna 25, a radio unit 21, a baseband signal processing unit 22, a radio control unit 23, an interface 24, and a transmission

notification unit 26. For FIG. 7, description is omitted other than for portions having a radio communication function. Moreover, the mobile stations 20b, 20c are also provided with a configuration similar to that of the mobile station 20a.

[0056]

The radio unit 21 performs radio transmission and reception of physical channels with the base station 10. The radio unit 21 transmits and receives the physical channels to and from the base station 10 via the antenna 25 as controlled by the radio control unit 23. The radio unit 21 acquires user data from the baseband signal processing unit 22 and acquires control data from the control unit 23.

10 [0057]

The radio control unit 23 controls the radio unit 21 so an enhanced uplink physical control signal conforming to enhanced access and a high-speed uplink physical control signal on a high-speed uplink physical control channel conforming to high-speed packet access are transmitted by time-division multiplexing. Specifically, the radio control unit 23 controls the radio unit 21 so the EULUL control signal is transmitted in the CQI slot included in HS-DPCCH.

[0058]

20 When a need to transmit the EULUL control signal arises, the radio control unit 23 sets the EULUL control signal in the CQI slot that normally sets the channel quality indicator (CQI) and instructs the radio unit 21 to transmit a high-speed uplink physical control signal on HS-DPCCH and the EULUL control signal by time-division multiplexing. That is, the radio control unit 23 instructs and controls the radio unit 21 so the EULUL control signal is transmitted in the CQI slot of HS-DPCCH.

[0059]

The radio control unit 23 may, for example, set the transmission interval of the EULUL control signal and the channel quality indicator (CQI) and perform instruction according to the set transmission interval, perform instruction according to a transmission interval designated by the base station 10, or perform instruction according to a transmission interval set in advance by operation.

[0060]

30 Furthermore, the radio control unit 23 performs acknowledgment and generates the acknowledgment (Ack). Moreover, the radio control unit 23 determines the downlink radio quality and generates the channel quality indicator (CQI). The radio control unit 23 inputs the acknowledgment (Ack), the channel quality indicator (CQI), and other control data to the radio unit 21. The transmission notification unit 26 notifies the base station 10 of transmission of the uplink physical control signal (EULUL control signal) as necessary. The transmission notification unit 26 inputs the notification of transmission of the EULUL control signal to the radio control unit 23.

[0061]

40 The interface 24 acquires user data from an external device or another function of the mobile station 20a and inputs these to the baseband signal processing unit 22. The baseband signal processing unit 22 subjects the user data acquired from the interface 24 to baseband signal processing and inputs the processed user data to the radio unit 21.

[0062]

As illustrated in FIG. 8, the base station 10 is provided with an antenna 15, a radio unit 11, a baseband signal processing unit 12, a control unit 13, a network interface 14, and a detection unit 16.

[0063]

The radio unit 11 performs radio transmission and reception of physical channels with the mobile stations 20a to 20c. The radio unit 11 receives an enhanced uplink physical control signal conforming to enhanced access transmitted by time-division multiplexing with a high-speed uplink physical control signal on a high-speed uplink physical control channel conforming to high-speed packet access. That is, the radio unit 11 receives a signal wherein the EULUL control signal and a high-speed uplink physical control signal on HS-DPCCH are subjected to time-division multiplexing.

[0064]

10 The radio unit 11 transmits and receives physical channels to and from the mobile stations 20a to 20c via the antenna 15 as controlled by the control unit 13. The radio unit 11 acquires user data from the baseband signal processing unit 12 and acquires control data from the control unit 13. The network interface 14 transmits and receives user data and control data to and from the radio control device 30. The baseband signal processing unit 12 subjects the user data acquired from the network interface 14 to baseband signal processing and inputs the processed user data to the radio unit 11.

[0065]

20 The control unit 13 controls the radio unit 11, the network interface 14, and the baseband signal processing unit 12. The detection unit 16 detects the enhanced uplink physical control signal from the high-speed uplink physical control signal and enhanced uplink physical control signal subjected to time-division multiplexing received by the radio unit 11. That is, the detection unit 16 detects the EULUL control signal from HS-DPCCH. The detection unit 16 detects the EULUL control signal transmitted in the CQI slot. The detection unit 16 monitors the radio unit 11 and inputs the detected EULUL control signal to the control unit 13.

[0066]

As illustrated in FIG. 9, the radio control device 30 is provided with a network interface 31 and a control unit 32. The network interface 31 transmits and receives control data and user data to and from a core network and the base station 10. The control unit 32 controls radio communication between the base station 10 and the mobile stations 20a to 20c.

30 [0067]

Next, a system for detecting the EULUL control signal from HS-DPCCH is detailed. In the mobile communication system 100, the EULUL control signal is transmitted in the CQI slot. At this time, the base station 10 distinguishes whether the signal being received in the CQI slot is an EULUL control signal or CQI and detects the EULUL control signal. Control between the mobile station 20a and the base station 10 is described below as an example.

[0068]

(First Transmission Method)

40 As a first transmission method, the radio unit 21 can be controlled so the radio control unit 23 of the mobile station 20a transmits the EULUL control signal at a timing known in the base station 10. In this situation, the detection unit 16 of the base station 10 can detect the EULUL control signal, transmitted at the timing known in the base station from the mobile station 20a, at the known timing. This enables the base station 10 to distinguish the EULUL control signal from among the signals subjected to time-division multiplexing.

[0069]

Specifically, as illustrated in FIG. 10, the mobile station 20a, like Ack and CQI on the HS-DPCCH 1c, transmits the EULUL control signal in the CQI slot at the timing known in the

base station 10. For example, the mobile station 20a transmits the EULUL control signal in the CQI slot according to a cycle known in the base station 10. This method is effective when the EULUL control signal is a signal to be sent in cycles.

[0070]

In FIG. 10, in the mobile station 20a transmitting the EULUL control signal and a high-speed uplink physical control signal on HS-DPCCH to the base station 10 by time-division multiplexing, a control device 40 sets a timing of transmitting the EULUL control signal and notifies the mobile station 20a and the base station 10 of the set timing. Accordingly, the set timing can be known in both the mobile station 20a and the base station 10.

10 [0071]

The control device 40 is provided with a setting unit 41 and a setting-content notification unit 42. In the mobile station 20a transmitting the EULUL control signal and the high-speed uplink physical control signal on HS-DPCCH to the base station 10 by time-division multiplexing, the setting unit 41 sets the timing of transmitting the EULUL control signal. The setting-content notification unit 42 notifies the mobile station 20a and the base station 10 of the timing set by the setting unit 41.

[0072]

The control device 40 can be provided in the base station 10, the radio control device 30, or the like. When the control device 40 is provided in the base station 10, the setting-content notification unit 42 notifies the base station 10 by notifying the detection unit 16 illustrated in FIG. 8 of the set timing as the timing of transmitting the EULUL signal known in the base station 10. When the control device 40 is provided in the radio control device 30, the setting-content notification unit 42 notifies the base station 10 of the set timing via the network interface 31 illustrated in FIG. 9. In both situations, the setting-content notification unit 42 notifies the mobile station 10 of the set timing via the base station 10.

20 [0073]

The setting unit 41 can set a constant transmission cycle as the timing of transmitting the EULUL control signal. For example, the setting unit 41 sets the transmission cycle to be three subframes. The setting-content notification unit 42 notifies the mobile station 20a and the base station 10 of the set transmission cycle of three subframes. The radio control unit 23 of the mobile station 20a controls the radio unit 21 so CQI transmission on the HS-DPCCH 1c is stopped every three subframes and the EULUL control signal is transmitted in the CQI slot.

30 [0074]

The detection unit 16 of the base station 10 can ascertain the timing of the mobile station 20a transmitting the EULUL control signal from the timing notification from the control device 40. Thus, the detection unit 16 detects the EULUL control signal in the CQI slot of the HS-DPCCH 1c received by the radio unit 11 every three subframes.

[0075]

The mobile station 20a can transmit, for example, RR (rate request) / SI (scheduling information) as the EULUL control signal to the base station 10. RR/SI is one of the EULUL control signals being discussed by 3GPP. RR and SI are information necessary in enhanced access for the base station 10 to calculate uplink radio resources to assign to the mobile station 20a.

40 [0076]

(Second Transmission Method)

As a second transmission method, the transmission notification unit 26 of the mobile station 20a notifies the base station 10 of transmission of the EULUL control signal. Then, the radio control unit 23 of the mobile station 20a controls the radio unit 21 so the EULUL control signal is transmitted according to the notification. In this situation, the detection unit 16 of the base station 10 can detect the EULUL control signal based on the notification of transmission of the EULUL control signal from the mobile station 20a. This enables the base station 10 to distinguish the EULUL control signal, from among the signals subjected to time-division multiplexing, based on the notification from the mobile station 20a.

[0077]

10 As illustrated in FIG. 11, the transmission notification unit 26 of the mobile station 20a uses the HS-DPCCH 1c to transmit a notification signal to the base station 10 prior to transmission of the EULUL control signal. The mobile station 20a stops CQI transmission and transmits the EULUL control signal. The mobile station 20a also stops CQI transmission and transmits the notification signal to the base station 10 in the CQI slot one subframe prior to transmission of the EULUL control signal. In this manner, the mobile station 20a can transmit the EULUL control signal immediately after transmission of the notification signal according to this notification signal. The base station 10 can receive the notification signal, ascertain transmission of the EULUL control signal, and detect the EULUL control signal.

[0078]

20 The transmission notification unit 26 of the mobile station 20a can perform the notification by transmitting at least one among a notification signal set to a value not used for control in high-speed packet access, a notification signal spread by a spread code different from a spread code used for a signal on a high-speed uplink physical control channel, and a notification signal of a different transmission power than a signal on the high-speed uplink physical control channel.

[0079]

30 In this situation, the detection unit 16 of the base station 10 can detect the enhanced uplink physical control signal based on at least one among a notification signal set to a value not used for control in high-speed packet access, a notification signal spread by a spread code different from a spread code used for a signal on the high-speed uplink physical control channel, and a notification signal of a different transmission power than a signal on the high-speed uplink physical control channel.

[0080]

40 Three notification signals will be described in more detail below. Firstly, as a notification signal set to a value not used for control in high-speed packet access, for example, the mobile station 20a can transmit as a notification signal a CQI value "31" that is not used in HSDPA. The CQI value "31" is represented as "CQI 31" hereinafter. The mobile station 20a transmits the CQI 31 in the CQI slot before the EULUL control signal is transmitted. Since a CQI is expressed in 5 bits, a total of 2 to the 5th power, or 32, CQIs can be handled in HSDPA. The current 3GPP specification reserves the CQI 31. Therefore, the base station 10 can recognized such as a notification signal due to the mobile station 20a transmitting the CQI 31 as a notification signal of the EULUL control signal transmission. Therefore, the detection unit 16 of the base station 10 can detect the EULUL signal.

[0081]

Thus, the mobile station 20a notifies the base station 10 of the transmission of the EULUL control signal via the physical layer. That is, the mobile station 20a gives a trigger of an

EULUL control signal transmission event to the base station 10. This notification method is effective when the nature of the EULUL control signal is a signal to be sent by an event trigger. [0082]

Secondly, as a notification signal spread by a spread code different from a spread code used for a signal on the high-speed uplink physical control channel, the mobile station 20a can, for example, transmit a notification signal spread by an OVSF (Orthogonal Variable Spreading Factor) code that is different from an OVSF code used for a signal on the high-speed uplink physical control channel. The signal on the HS-DPCCH 1c is spread by a fixed OVSF code, including the CQI. Therefore, the mobile station 20a can transmit a signal spread by an OVSF code different from the CQI to the base station 10 as a notification signal. The detection unit of the base station 10 can recognize the signal spread by an OVSF code different from the CQI as a notification signal. Therefore, the detection unit 16 of the base station 10 can detect the EULUL signal. For example, the mobile station 20a can use an OVSF code having a code tree different from that of the CQI, an OVSF code having the same code tree as that of the CQI but having a branch different from that of the CQI, or the like. [0083]

Thirdly, the mobile station 20a can transmit, as a notification signal for which the transmission power is different from the signal on the high-speed uplink physical control channel, a notification signal for which a power offset (Power Offset; hereinafter represented as “PO”) at the time of transmission is changed. The CQI is transmitted via a fixed PO designated by the control device 40. The mobile station 20a can transmit, as a notification signal, a CQI for notification using a PO higher than the PO at the time of normal CQI transmission. [0084]

In this situation, as illustrated in FIG. 12, the detection unit 16 of the base station 10 performs received power determination. When the received power of the base station 10 is higher than a power threshold value, the detection unit 16 determines that the signal is a notification signal and detects transmission of the EULUL control signal. Conversely, when the received power is lower than the power threshold value, the detection unit 16 determines that this is a normal CQI and determines that the EULUL control signal is not transmitted. [0085]

The mobile station 20a and the base station 10 may choose between using a first transmission method or a second transmission method according to the application. Furthermore, the control device 40 may set which to apply and instruct the mobile station 20a and the base station 10 of such. Specifically, as illustrated in FIG. 13, the setting unit 41 of the control device 40, in the mobile station 20a transmitting the EULUL control signal and the high-speed uplink physical control signal on the HS-DPCCH 1c by time-division multiplexing, sets which to perform among a first transmission method of transmitting the EULUL control signal at a timing known in the base station 10, and a second transmission method of notifying, from the mobile station 20 to the base station 10, transmission of the UELUL control signal and transmitting the EULUL control signal according to the notification. The setting-content notification unit 42 notifies the mobile station 20a and the base station 10 of either among the first transmission method and the second transmission method set by the setting unit 41. Note that the setting-content notification unit 42 need only notify at least the mobile station 20a of the transmission method. Accordingly, the control device 40 can cause the mobile station 20a to choose between using the first transmission method or the second transmission method as necessary. [0086]

(Transmission Power Control)

Next, transmission power control of the EULUL control signal and the notification signal will be described. Signals such as Ack, Nack, and CQI transmitted on HS-DPCCH have different channel coding methods and required qualities for the signals. For example, as illustrated in FIG. 14, Ack, Nack, and CQI each have different required POs at the time of transmission required to satisfy the required quality. Therefore, as illustrated in FIG. 15, the setting unit 41 of the control device 40 can set the PO at the time of Ack transmission (hereinafter represented as “Ack PO”), the PO at the time of Nack transmission (hereinafter represented as “Nack PO”), and the PO at the time of CQI transmission (hereinafter represented as “CQI PO”) to respectively different values.

[0087]

When an EULUL control signal is transmitted via a CQI slot on the HS-DPCCH 1c, the channel coding or required quality of the EULUL control signal may be different from that of the CQI. Therefore, the setting unit 41 of the control device 40 sets the PO used when transmitting the EULUL control signal in the CQI slot, separately from the CQI PO. The PO at the time of transmission of the EULUL control signal is represented as “EUL PO” below.

[0088]

Specifically, the setting unit 41 sets the EUL PO as a control signal transmission power value that transmits the EULUL control signal. The setting-content notification unit 42 notifies the mobile station 20a and the base station 10 of the EUL PO as the control signal transmission power value set by the setting unit 41. Note that the setting-content notification unit 42 need only notify at least the mobile station 20a of the control signal transmission power value. Then, the radio control unit 23 of the mobile station 20a controls the transmission power for transmitting the EULUL control signal. The radio control unit 23 uses the EUL PO notified by the control device 40 to transmit the EULUL control signal. Accordingly, the mobile station 20a can satisfy the required quality of the UELUL control signal by controlling the transmission power.

[0089]

For example, as illustrated in FIG. 16, the setting unit 41 of the control device 40 sets the EUL PO. Specifically, the setting unit 41 sets EUL PO = 9 separately from Ack PO = 6, Nack PO = 7, and CQI PO = 3. Then, the setting-content notification unit 42 notifies the mobile station 20a and the base station 10 of Ack PO = 6, Nack PO = 7, CQI PO = 3, and EUL PO = 9. The mobile station 20a uses the notified Ack PO = 6, Nack PO = 7, CQI PO = 3, and EUL PO = 9 to transmit Ack, Nack, CQI, and EULUL control signals. Thus, the mobile station 20a can satisfy the required quality of the EULUL control signal without affecting other signals.

[0090]

Furthermore, as described above, a notification signal may be transmitted. The required quality of a notification signal used for detecting the transmission of the EULUL control signal may be different from the CQI or EULUL control signal. Therefore, the control device 40 sets the PO used when transmitting the notification signal (hereinafter represented as “notification signal PO”) independently of the CQI PO and the EUL PO.

[0091]

Specifically, as illustrated in FIG. 17, the setting unit 41 of the control device 40 sets, as the notification signal transmission power value, the notification signal PO of the notification signal transmitted for transmission detection of the EULUL control signal. The setting-content notification unit 42 notifies the mobile station and the base station 10 of the notification signal PO. Note that the setting-content notification unit 42 need only notify at least the mobile station

20a of the notification signal transmission power value. Then, the radio control unit 23 of the mobile station 20a controls the transmission power for transmitting the notification control signal. The radio control unit 23 uses the notification signal PO notified by the control device 40 to control the radio unit 21 to transmit the notification signal. Thus, the required quality of the transmission signal for detecting the EULUL control signal transmission can be satisfied without affecting other signals.

[0092]

For example, as illustrated in FIG. 17, the setting unit 41 of the control device 40 sets notification signal PO = 12 separately from Ack PO = 6, Nack PO = 7, CQI PO = 3, and EUL PO = 9. Then, the setting-content notification unit 42 notifies the mobile station 20a and the base station 10 of Ack PO = 6, Nack PO = 7, CQI PO = 3, EUL PO = 9, and notification signal PO = 12. The mobile station 20a uses the notified Ack PO = 6, Nack PO = 7, CQI PO = 3, EUL PO = 9, and notification signal PO = 12 to transmit Ack, Nack, CQI, and EULUL control signals and a notification signal.

[0093]

(Determination Method)

Next, a method for determining the notification signal will be described. When the mobile station 20a transmits a notification signal to the base station 10, there is a possibility that the base station 10 may determine the transmitted signal to be a notification signal when the mobile station 20a, according to HSDPA, transmits a normal CQ (CQI having a CQI value of 0 to 30) or transmits a DTX (Discontinuous Transmission). Also, the base station 10 may mistake a signal received in the next CQI slot as an EULUL control signal. Thus, the base station 10 reflects a normal CQI according to HSDPA in operations according to enhanced access. Furthermore, the base station 10 cannot reflect a normal CQI according to HSDPA in HSDPA scheduling. As a result, there is a risk of inviting quality degradation of data transmission via enhanced access or HSDPA.

[0094]

Therefore, the detection unit 16 of the base station 10 preferably determines a reliability of the notification and detects the EULUL control signal based on a result of this determination. This enables the base station 10 to more appropriately detect the EULUL control signal. In this situation, the setting unit 41 of the control device 40 sets a reliability threshold of the notification. The setting-content notification unit 42 notifies the base station 10 of the reliability threshold set by the setting unit 41. This enables the control device 40 to more appropriately control detection of the EULUL control signal by the base station 10.

[0095]

Specifically, as illustrated in FIG. 18, the setting unit 41 sets notification signal reliability determination threshold = σ as the reliability threshold of the notification. The setting-content notification unit 42 notifies the base station 10 and the mobile station 20a of notification signal reliability determination threshold = σ . Note that the setting-content notification unit 42 need only notify at least the base station 10 of the notification signal reliability determination threshold. The mobile station 20a transmits a transmission HS-DPCCH 101 including the notification signal to the base station 10.

[0096]

The base station 10 receives an HS-DPCCH 102 before reliability determination. The detection unit 16 of the base station 10 calculates a reliability of a notification signal included in the received HS-DPCCH 102. The detection unit 16 performs reliability determination by

comparing notification signal reliability determination threshold = σ notified by the control device 40 to a calculated reliability value. The base station 10 determines a notification signal when the calculated value of the reliability is higher than notification signal reliability determination threshold = σ , and determines that the CQI is being transmitted normally when the calculated value is lower.

[0097]

For example, because the base station 10 has received the notification signal in the subframe number 1, reliability determination is performed. Because the mobile station 20a transmits the notification signal in the subframe number 1, it is possible to obtain a determination result that the reliability of the notification signal calculated by the base station 10 is higher than notification signal reliability determination threshold = σ . Therefore, the base station 10 determines that a notification signal has been received. Then, the EULUL control signal transmitted in the next CQI slot is detected.

[0098]

Conversely, in the subframe number 3, the mobile station 20a transmits a normal CQI according to HSDPA, but the base station 10 receives the notification signal by mistake. Therefore, it is possible to obtain a determination result that the reliability of the notification signal calculated by the base station 10 is lower than notification signal reliability determination threshold = σ . Therefore, the base station 10 determines that a normal CQI has been received.

Thus, a subframe number 3 is a normal CQI in an HS-DPCCH 103 after reliability determination. Thus, it is possible to prevent the base station 10 from mistaking a normal CQI transmitted in a next CQI slot of the subframe number 3 as an EULUL control signal. Therefore, quality degradation of data transmission via enhanced access or HSDPA can be prevented.

[0099]

Next, determination of the EULUL control signal itself will be described. The mobile station 20a transmits the EULUL control signal after imparting a correct/incorrect determination bit such as a CRC (Cyclic Redundancy Check) bit. Because the detection unit 16 of the base station 10 has not received a notification signal, at the time of decoding a signal in the CQI slot as a normal CQI according to HSDPA, simultaneously, decoding of this signal as a EULUL control signal is attempted, and CRC determination is performed. When the determination result of the CRC is negative, the detection unit 16 determines that the signal was a normal CQI.

Conversely, when the determination result of the CRC is positive, the detection unit 16 determines that the signal was an EULUL control signal.

[0100]

For example, as illustrated in FIG. 19, the mobile station 20a transmits a normal CQI in accordance with HSDPA in subframe number 1 and subframe number 2, transmits a notification signal in subframe number 3, and transmits a transmission HS-DPCCH 104 that transmits an EULUL signal in subframe number 4.

[0101]

The base station 10 receives a normal CQI in subframe number 1, subframe number 2, and subframe number 3, receives a normal CQI in subframe number 4, and receives an HS-DPCCH 105 before CRC determination. The base station 10 decodes the received normal CQIs as EULUL control signals and performs CRC determination. The base station 10 determines that the base station 10 successfully received a normal CQI because the CRC determination result is negative for subframe numbers 1 and 2. Conversely, because the base station 10 determines that the CRC determination result of subframe number 4 is positive, the base station 10 determines

that an EULUL control signal was received in subframe number 4. As a result, the base station 10 determines that an HS-DPCCH 106 after CRC determination has been received. Therefore, the base station 10 can prevent misidentification of the EULUL control signal as a normal CQI according to HSDPA.

[0102]

The detection unit 16 of the base station 10 preferably performs both reliability determination of the notification signal and CRC determination of the EULUL signal. For example, the detection unit 16 can perform CRC determination only when the reliability is lower than a reliability threshold.

10 [0103]

(Effect)

According to such mobile communication system 100, mobile stations 20a to 20c, base station 10, control device 40, and mobile communication method, the transmission quality of physical channels (HS-DPCCH and HS-DSCH) according to high-speed packet access is hardly affected due to time-division multiplexing and transmitting an enhanced uplink physical control signal (EULUL control signal) and a high-speed uplink physical control signal on a high-speed uplink physical control channel (HS-DPCCH) conforming to high-speed packet access. Moreover, because time-division multiplexing is performed, an increased code-division multiplexing count of simultaneously transmitted signals can be prevented. As such, an increased peak-to-average ratio (PAR) in transmission power of the mobile stations 20a to 20c can be prevented.

20 [0104]

In particular, in the mobile communication system 100, an enhanced uplink physical control signal (EULUL control signal) can be transmitted in a quality time slot (CQI slot) for transmitting a channel quality indicator (CQI) included in a high-speed uplink physical control channel (HS-DPCCH) conforming to high-speed packet access. As illustrated in FIG. 6, suppressing a transmission frequency of a channel quality indicator (CQI) hardly affects a data transmission throughput. As such, the mobile communication system 100 can prevent transmission quality degradation of existing physical channels (HS-DSCH).

30 [0105]

Therefore, according to the mobile communication system 100, the mobile stations 20a to 20c, the base station 10, the control device 40, and the mobile communication method, an enhanced uplink physical control signal (EULUL control signal) can be transmitted without affecting existing physical channels (DPDCH, DPCCH, HS-DPCCH, HS-DSCH) or increasing the peak-to-average ratio in the transmission power of the mobile stations 20a to 20c.

[0106]

(Modifications)

The present invention is not limited to the embodiments described above, and various modifications are possible. For example, it is possible to construct not only a mobile communication system that essentially employs both enhanced access (EUL) and HSDPA, but also a mobile communication system that essentially employs only enhanced access (EUL).

40 [0107]

Therefore, transmission and reception of EULUL control signals between the mobile stations 20a to 20c and the base station 10 in the embodiments described above can be applied, for example, to a mobile communication system that essentially employs only enhanced access (EUL). Specifically, in a mobile communication system wherein EUL is applied in uplink but

HSDPA is not applied in downlink between the mobile station and the base station, when transmitting HS-DPCCH, it is assumed that a normal CQI is always DTX-transmitted, and transmission and reception of EULUL control signals is performed in the same manner as the embodiments described above.

[0108]

For example, as illustrated in FIG. 20, when starting HS-DPCCH 1c transmission, the base station 10 and the mobile station 20a can send and receive signals while assuming that DTX transmission is performed without transmitting anything in a time slot in which a notification signal or an EULUL control signal is not transmitted. Accordingly, it is not necessary to develop a system according to differences in operation forms, and cost reduction can be achieved.

[Brief Description of the Drawings]

[0109]

[FIG. 1] A diagram illustrating a configuration of a mobile communication system according to an embodiment of the present invention.

[FIG. 2] A diagram illustrating physical channel transmission according to an embodiment of the present invention.

[FIG. 3] A diagram describing a physical channel in uplink when an E-DPDCH/EPLUL control signal according to an embodiment of the present invention is not transmitted.

[FIG. 4] A diagram describing a physical channel (frame length of 10 ms) in uplink when an E-DPDCH/EPLUL control signal according to an embodiment of the present invention is transmitted.

[FIG. 5] A diagram describing a physical channel (frame length of 2 ms) in uplink when an E-DPDCH/EPLUL control signal according to an embodiment of the present invention is transmitted.

[FIG. 6] A graph showing the effect of the transmission interval of a channel quality indicator (CQI) on the throughput of data transmission.

[FIG. 7] A block diagram illustrating a configuration of a mobile station according to an embodiment of the present invention.

[FIG. 8] A block diagram illustrating a configuration of a base station according to an embodiment of the present invention.

[FIG. 9] A block diagram illustrating a configuration of radio control device according to an embodiment of the present invention.

[FIG. 10] A diagram illustrating a situation wherein a known timing according to an embodiment of the present invention is used.

[FIG. 11] A diagram illustrating a situation wherein a notification signal according to an embodiment of the present invention is used.

[FIG. 12] A diagram illustrating received power determination according to an embodiment of the present invention.

[FIG. 13] A diagram illustrating a situation wherein a transmission method according to an embodiment of the present invention is set.

[FIG. 14] A diagram illustrating differences in required PO by signals according to an embodiment of the present invention.

[FIG. 15] A diagram illustrating PO setting according to an embodiment of the present invention.

[FIG. 16] A diagram illustrating PO setting (when including the EUL PO) according to an embodiment of the present invention.

[FIG. 17] A diagram illustrating PO setting (when including the notification setting PO) according to an embodiment of the present invention.

[FIG. 18] A diagram illustrating reliability determination of a notification signal according to an embodiment of the present invention.

[FIG. 19] A diagram illustrating CRC determination of an EULUL control signal according to an embodiment of the present invention.

[FIG. 20] A diagram illustrating a mobile communication system according to a modification of the present invention.

[FIG. 21] A diagram illustrating an existing uplink.

10 [FIG. 22] A diagram illustrating a first method, a second method, and a third method.

[Description of Reference Numerals]

[0110]

100 Mobile communication system

10 Base station

11 Radio unit

12 Baseband signal processing unit

13 Control unit

14 Detection unit

15 Antenna

20 20a, 20b, 20c Mobile station

21 Radio unit

22 Baseband signal processing unit

23 Radio control unit

24 Interface

25 Antenna

26 Transmission notification unit

30 Radio control device

31 Network interface

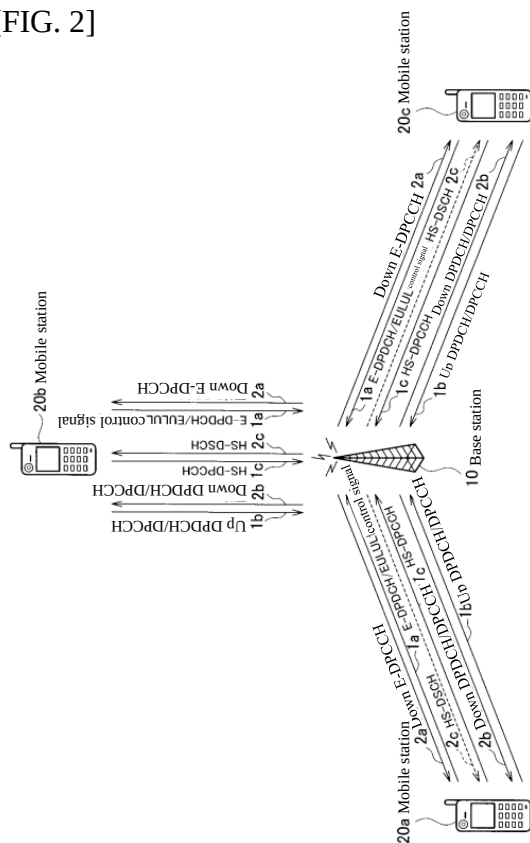
32 Control unit

30 40 Control device

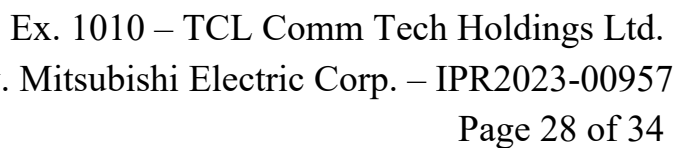
41 Setting unit

42 Setting-content notification unit

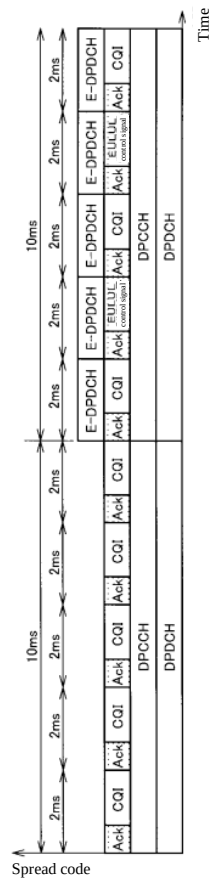
[FIG. 2]



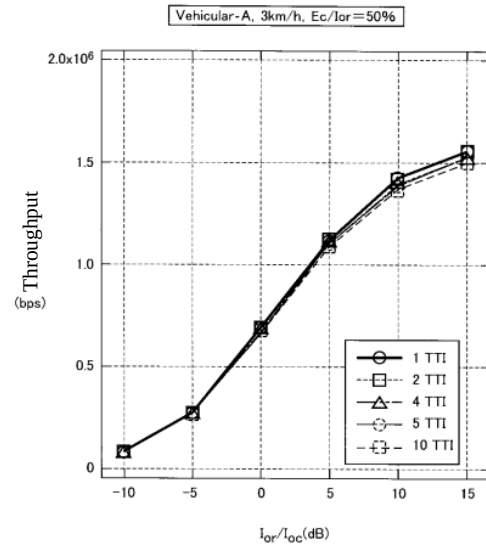
[FIG. 4]



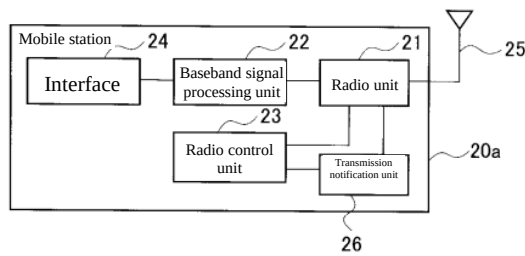
[FIG. 5]



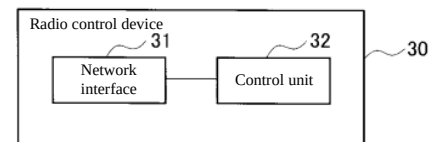
[FIG. 6]



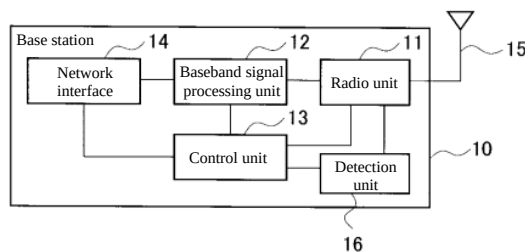
[FIG. 7]



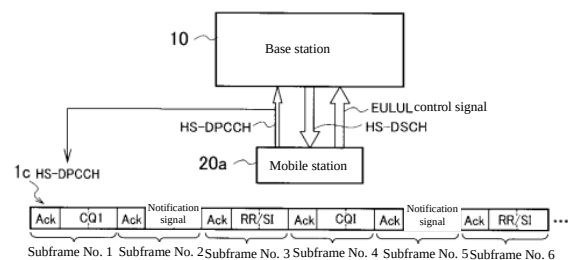
[FIG. 9]



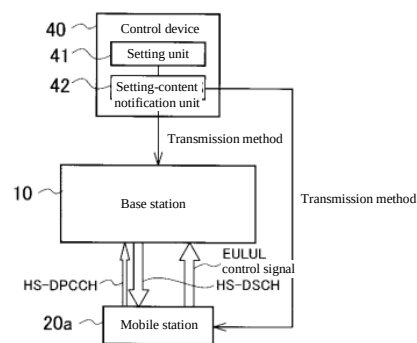
[FIG. 8]



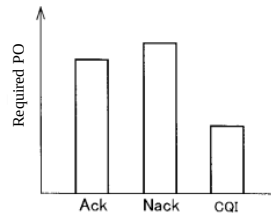
[FIG. 11]



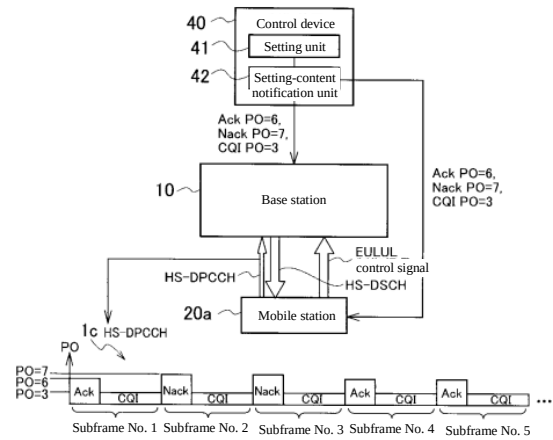
[FIG. 13]



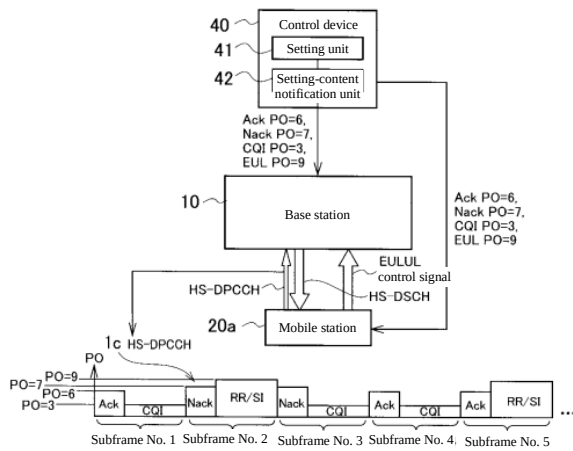
[FIG. 14]



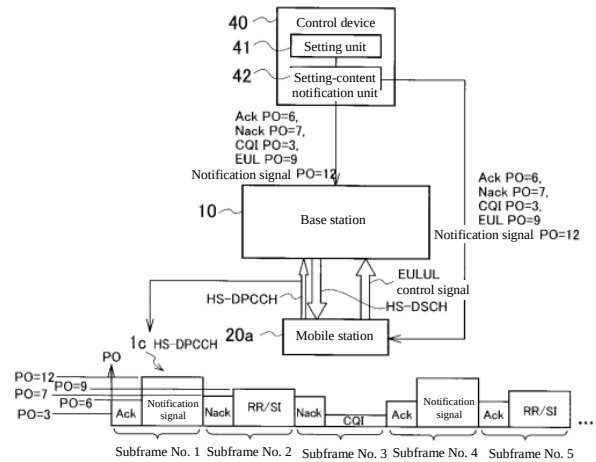
[FIG. 15]



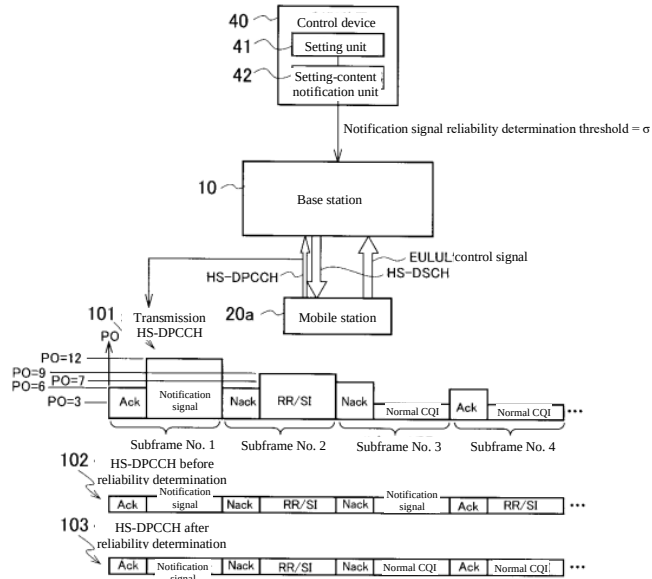
[FIG. 16]



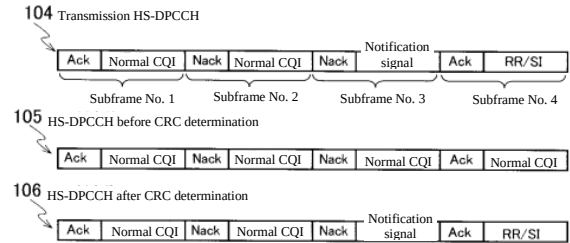
[FIG. 17]



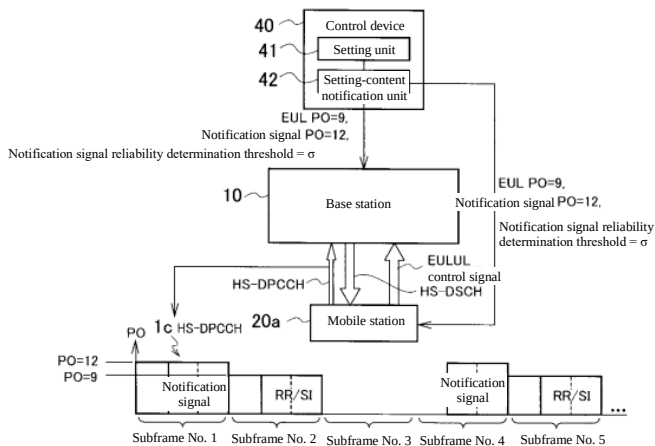
[FIG. 18]



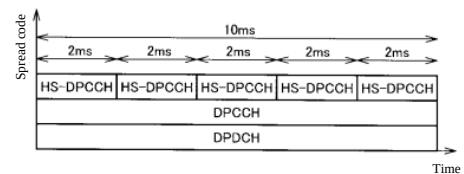
[FIG. 19]



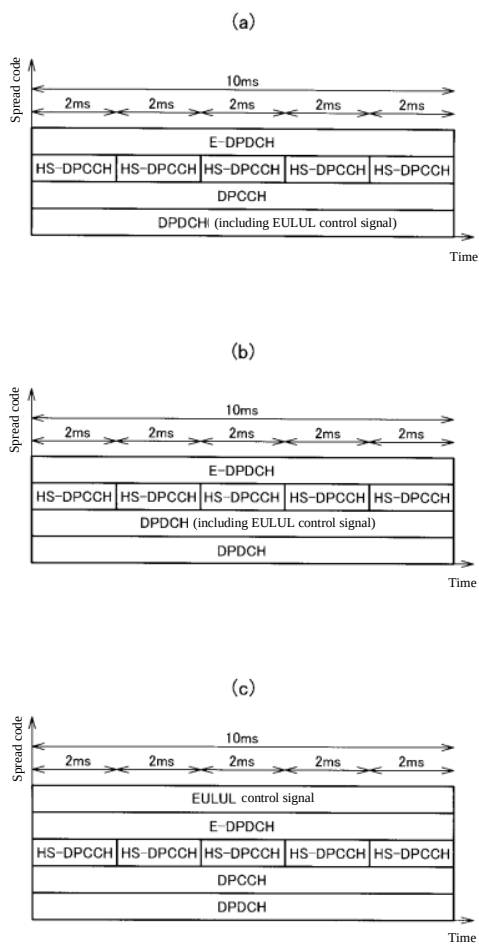
[FIG. 20]



[FIG. 21]



[FIG. 22]



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