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(12) **Reissued Patent**
Kato et al.

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(45) **Date of Reissued Patent: Jun. 4, 2019**

(54) **BASE STATION DEVICE, MOBILE STATION DEVICE, COMMUNICATION SYSTEM AND COMMUNICATION METHOD**

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(73) Assignee: **SHARP KABUSHIKI KAISHA**, Sakai, Osaka (JP)

(21) Appl. No.: **14/656,229**

(22) Filed: **Mar. 12, 2015**

Related U.S. Patent Documents

Reissue of:
(64) Patent No.: **8,396,032**
Issued: **Mar. 12, 2013**
Appl. No.: **12/665,634**
PCT Filed: **Mar. 14, 2008**
PCT No.: **PCT/JP2008/054757**
§ 371 (c)(1),
(2) Date: **Dec. 18, 2009**
PCT Pub. No.: **WO2008/155935**
PCT Pub. Date: **Dec. 24, 2008**

(30) **Foreign Application Priority Data**

Jun. 19, 2007 (JP) 2007-161020

(51) **Int. Cl.**
H04W 56/00 (2009.01)
H04B 1/7073 (2011.01)

(52) **U.S. Cl.**
CPC ***H04W 56/0045*** (2013.01); *H04B 1/70735* (2013.01)

(58) **Field of Classification Search**
CPC H04W 56/0045; H04B 1/70735
See application file for complete search history.

(56) **References Cited**

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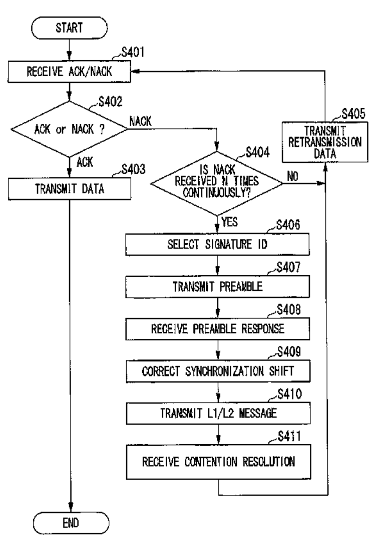
(Continued)

Primary Examiner — John M Hotaling
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

A base station device which communicates with a mobile station device, comprising an uplink synchronization managing unit which manages uplink synchronization maintenance status of the mobile station device, and a transmitting unit which transmits a synchronization recovery request to the mobile station which is in the uplink synchronization maintenance status.

8 Claims, 25 Drawing Sheets



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3GPP TS (Technical Specification) 36.212, V1.2.0 (2007-05), 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Multiplexing and channel coding (Release 8).

U.S. Office Action issued in U.S. Appl. No. 12/665,634 dated Jul. 27, 2012 is attached hereto.

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Nortel Networks: "Consideration on UL RACH scheme for LTE", 3GPP Draft; R1-060653 RACH, 3rd Generation Partnership Project (3GPP), Mobile Competence Centre, 650, Route Des Lucioles; F-06921 Sophia-Antipolis Cedex; France, vol. RAN WG1, no. Denver, USA; Feb. 9, 2006, XP050101574, [retrieved on Feb. 9, 2006].

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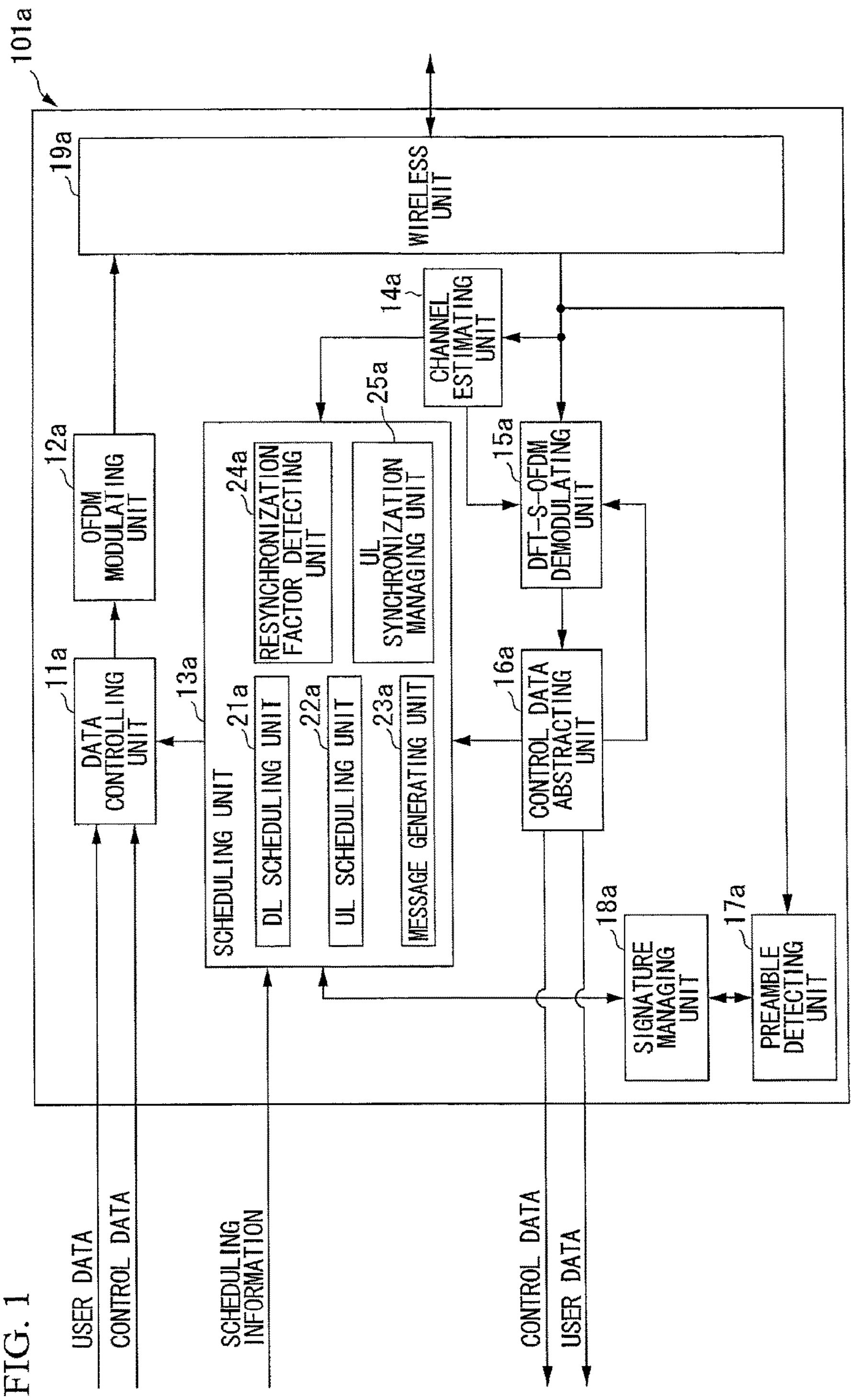

101a
19a
WIRELESS UNIT
14a
CHANNEL ESTIMATING UNIT
12a
OFDM MODULATING UNIT
25a
24a
RESYNCHRONIZATION FACTOR DETECTING UNIT
UL SYNCHRONIZATION MANAGING UNIT
15a
DFT-S-OFDM DEMODULATING UNIT
11a
DATA CONTROLLING UNIT
13a
21a
22a
23a
16a
CONTROL DATA ABSTRACTING UNIT
SCHEDULING UNIT
DL SCHEDULING UNIT
UL SCHEDULING UNIT
MESSAGE GENERATING UNIT
18a
17a
SIGNATURE MANAGING UNIT
PREAMBLE DETECTING UNIT
USER DATA
CONTROL DATA
SCHEDULING INFORMATION
CONTROL DATA
USER DATA

FIG. 1

FIG. 2

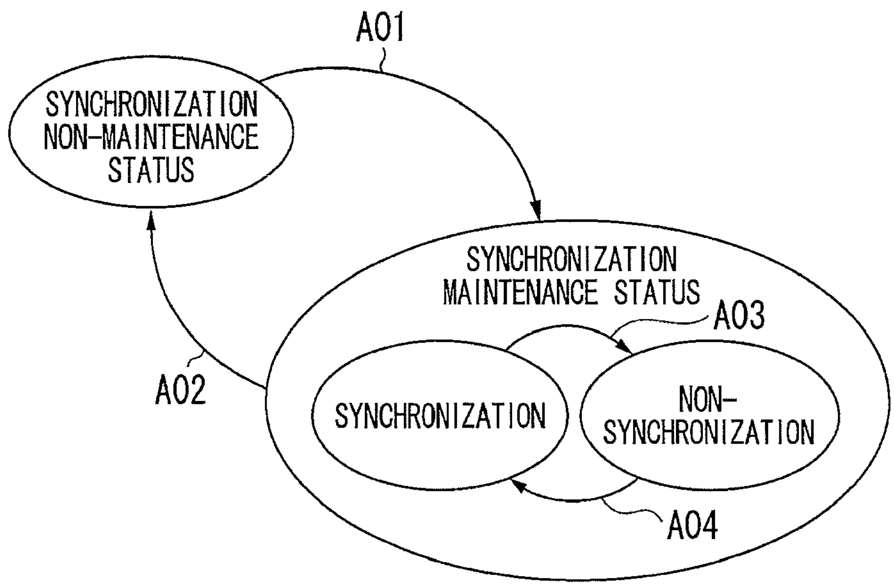

A01
SYNCHRONIZATION NON-MAINTENANCE STATUS
SYNCHRONIZATION MAINTENANCE STATUS
A03
A02
SYNCHRONIZATION
NON-SYNCHRONIZATION
A04

FIG. 3

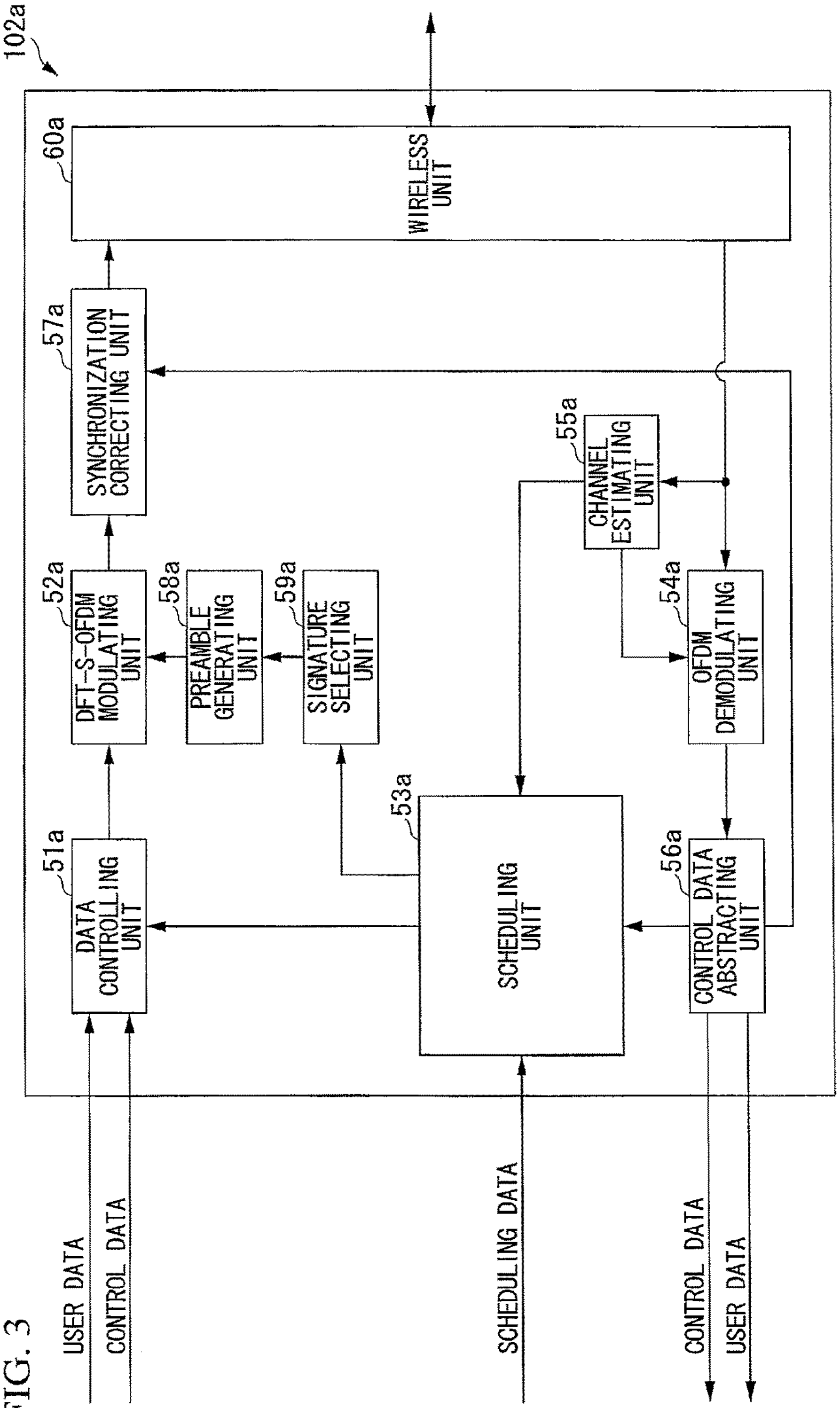
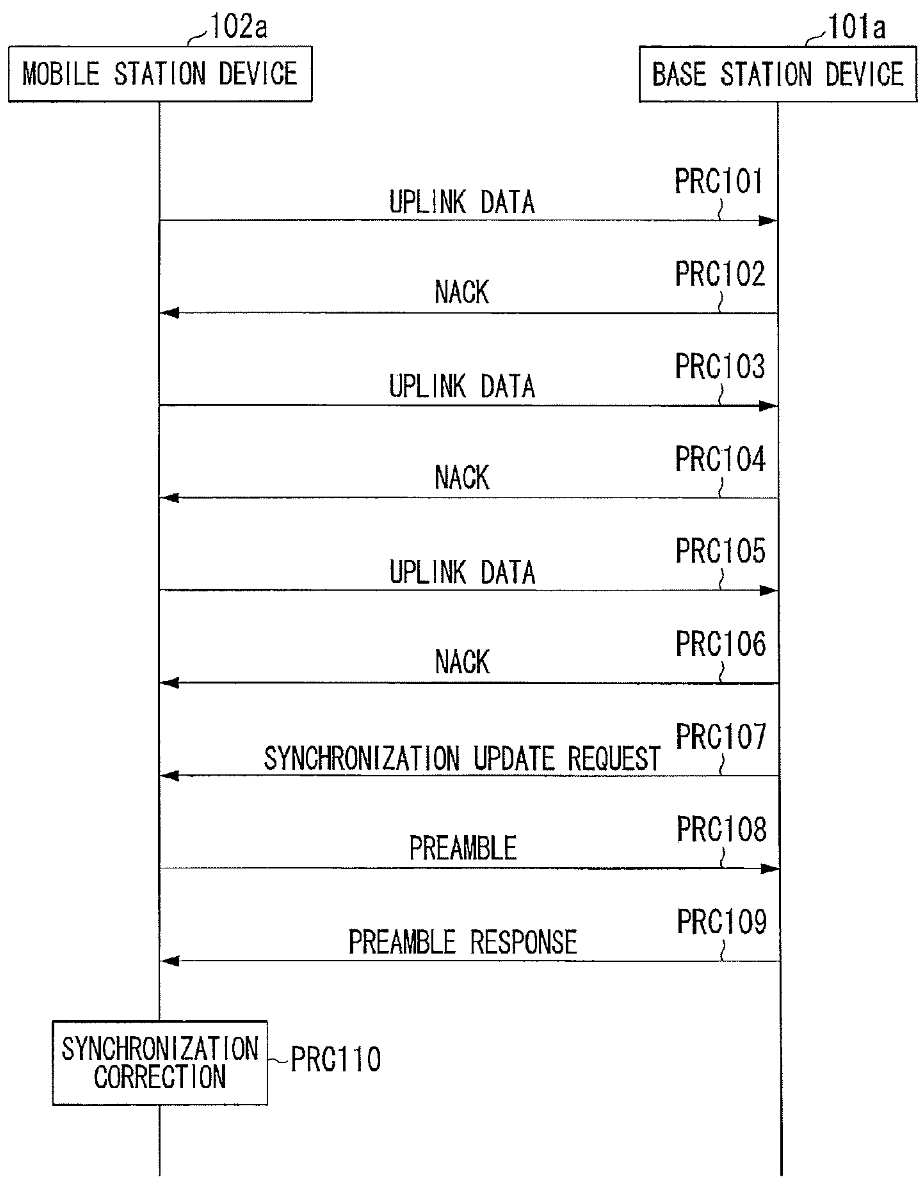

102a
60a
WIRELESS UNIT
57a
SYNCHRONIZATION CORRECTING UNIT
55a
CHANNEL ESTIMATING UNIT
52a
DFT-S-OFDM MODULATING UNIT
58a
PREAMBLE GENERATING UNIT
59a
SIGNATURE SELECTING UNIT
54a
OFDM DEMODULATING UNIT
53a
SCHEDULING UNIT
51a
DATA CONTROLLING UNIT
56a
CONTROL DATA ABSTRACTING UNIT
USER DATA
CONTROL DATA
SCHEDULING DATA
CONTROL DATA
USER DATA

FIG. 4



102a
MOBILE STATION DEVICE
101a
BASE STATION DEVICE
UPLINK DATA
PRC101
NACK
PRC102
UPLINK DATA
PRC103
NACK
PRC104
UPLINK DATA
PRC105
NACK
PRC106
SYNCHRONIZATION UPDATE REQUEST
PRC107
PREAMBLE
PRC108
PREAMBLE RESPONSE
PRC109
SYNCHRONIZATION CORRECTION
PRC110

FIG. 5

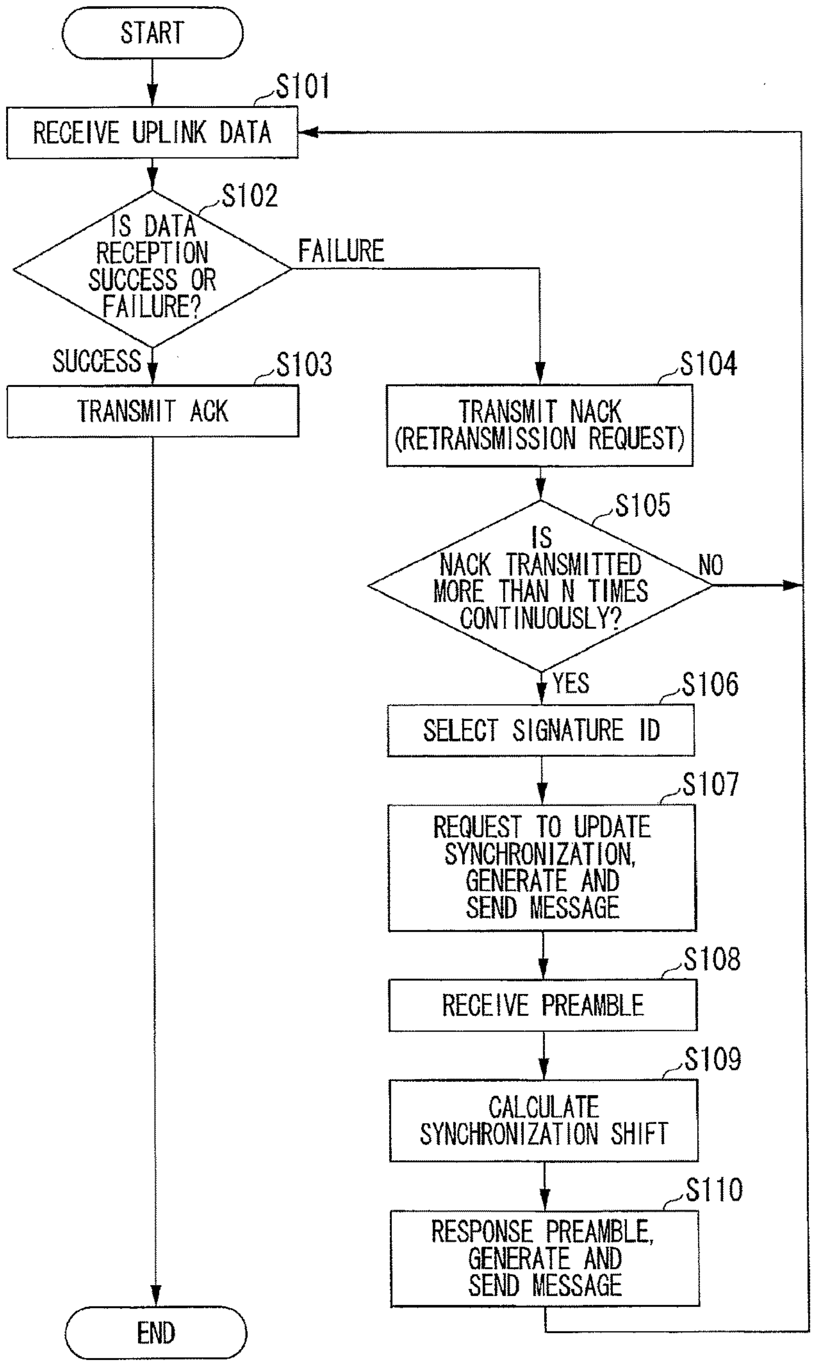

START
S101
RECEIVE UPLINK DATA
S102
IS DATA RECEPTION SUCCESS OR FAILURE?
FAILURE
SUCCESS
S103
TRANSMIT ACK
S104
TRANSMIT NACK (RETRANSMISSION REQUEST)
S105
IS NACK TRANSMITTED MORE THAN N TIMES CONTINUOUSLY?
NO
YES
S106
SELECT SIGNATURE ID
S107
REQUEST TO UPDATE SYNCHRONIZATION, GENERATE AND SEND MESSAGE
S108
RECEIVE PREAMBLE
S109
CALCULATE SYNCHRONIZATION SHIFT
S110
RESPONSE PREAMBLE, GENERATE AND SEND MESSAGE
END

FIG. 6

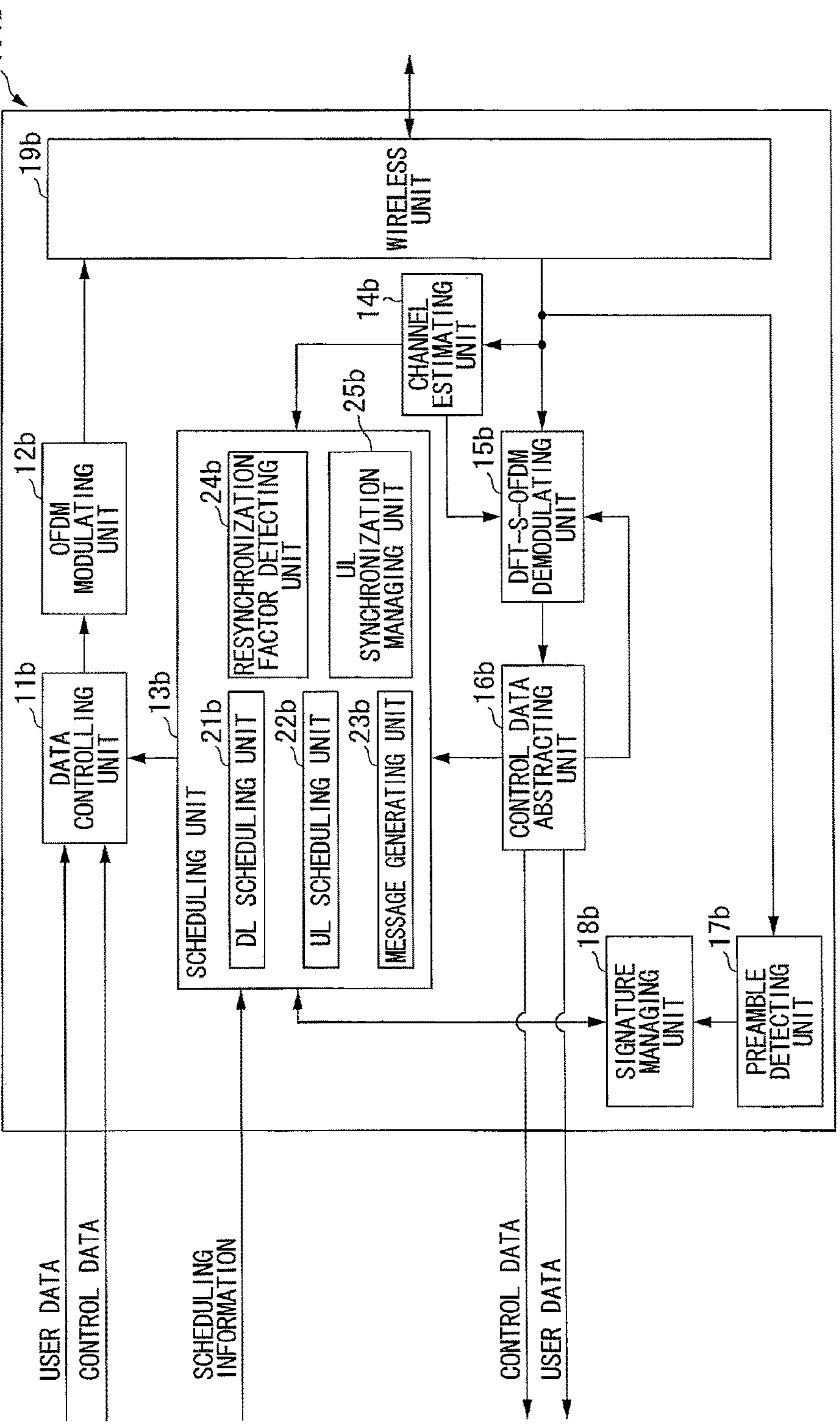

101b
19b
WIRELESS UNIT
14b
CHANNEL ESTIMATING UNIT
12b
OFDM MODULATING UNIT
25b
24b
RESYNCHRONIZATION FACTOR DETECTING UNIT
UL SYNCHRONIZATION MANAGING UNIT
15b
DFT-S-OFDM DEMODULATING UNIT
11b
DATA CONTROLLING UNIT
13b
21b
22b
23b
16b
CONTROL DATA ABSTRACTING UNIT
SCHEDULING UNIT
DL SCHEDULING UNIT
UL SCHEDULING UNIT
MESSAGE GENERATING UNIT
18b
17b
SIGNATURE MANAGING UNIT
PREAMBLE DETECTING UNIT
USER DATA
CONTROL DATA
SCHEDULING INFORMATION
CONTROL DATA
USER DATA

FIG. 7

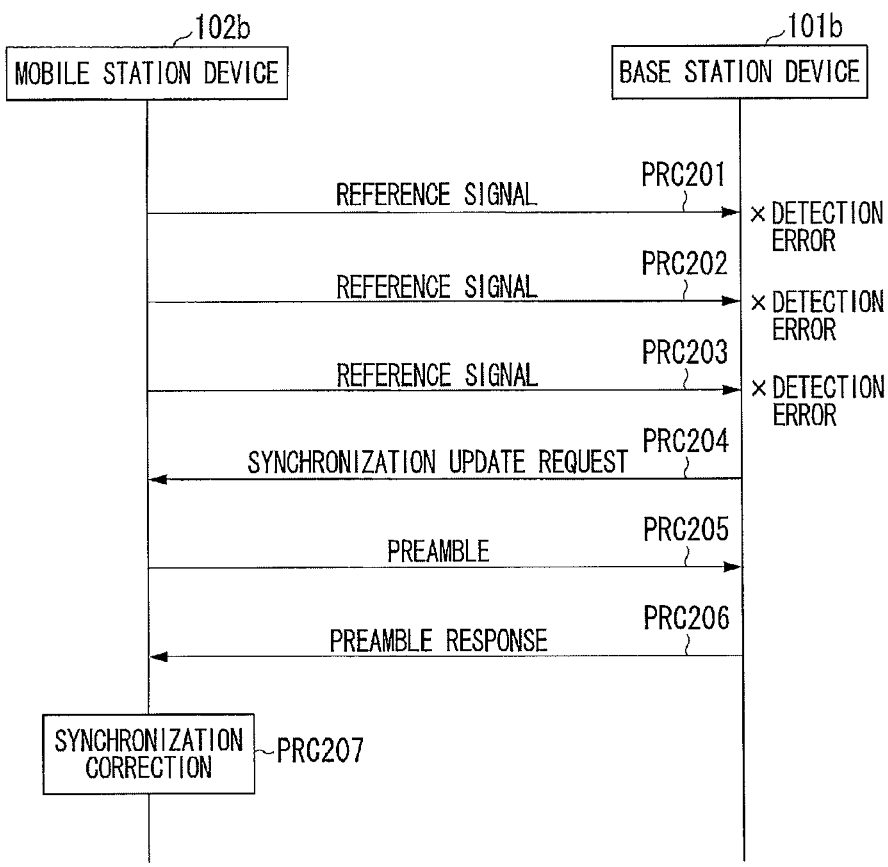

102b
MOBILE STATION DEVICE
101b
BASE STATION DEVICE
PRC201
REFERENCE SIGNAL
× DETECTION ERROR
PRC202
REFERENCE SIGNAL
× DETECTION ERROR
PRC203
REFERENCE SIGNAL
× DETECTION ERROR
PRC204
SYNCHRONIZATION UPDATE REQUEST
PRC205
PREAMBLE
PRC206
PREAMBLE RESPONSE
SYNCHRONIZATION CORRECTION
PRC207

FIG. 8

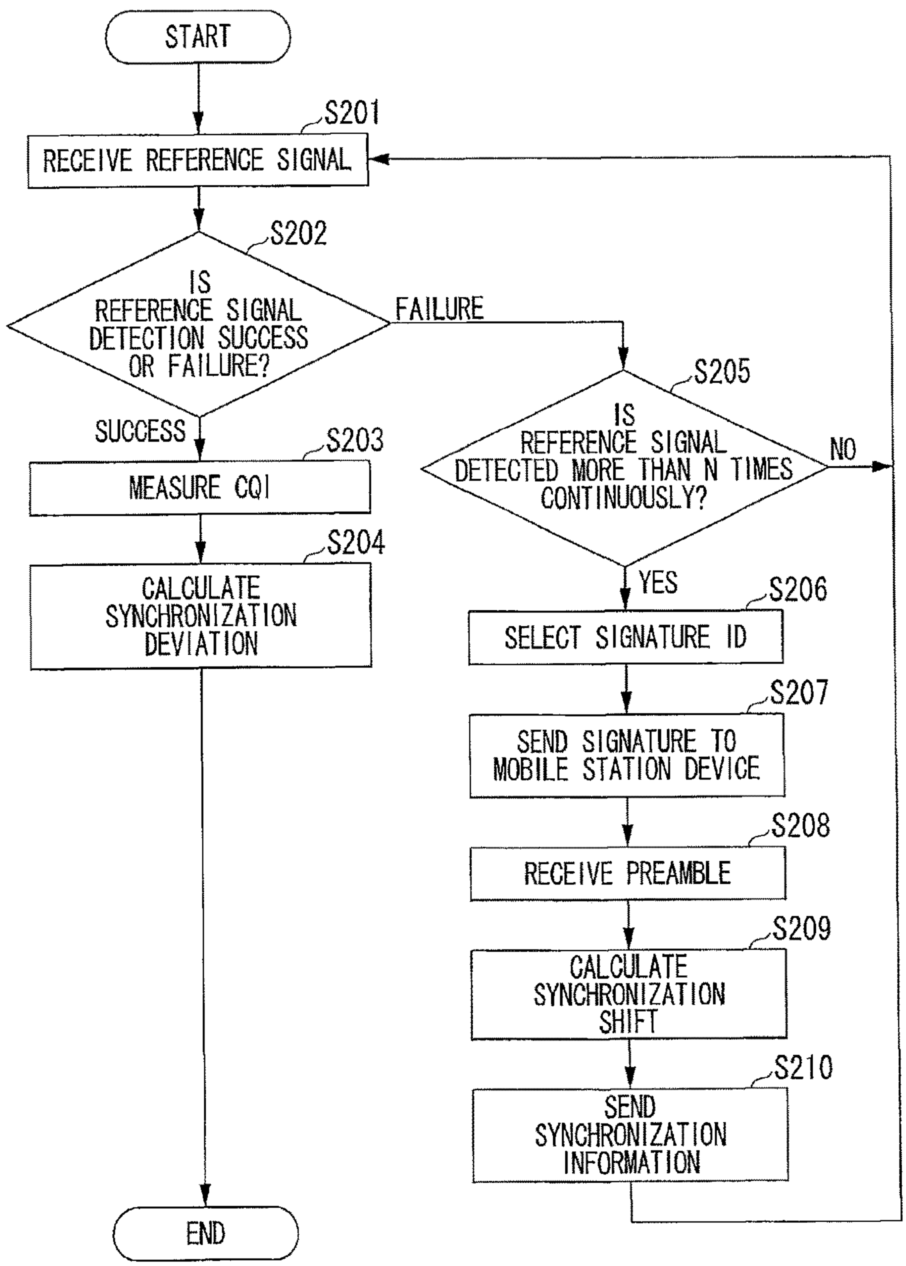

START
S201
RECEIVE REFERENCE SIGNAL
S202
IS REFERENCE SIGNAL DETECTION SUCCESS OR FAILURE?
FAILURE
SUCCESS
S203
MEASURE CQI
S204
CALCULATE SYNCHRONIZATION DEVIATION
S205
IS REFERENCE SIGNAL DETECTED MORE THAN N TIMES CONTINUOUSLY?
NO
YES
S206
SELECT SIGNATURE ID
S207
SEND SIGNATURE TO MOBILE STATION DEVICE
S208
RECEIVE PREAMBLE
S209
CALCULATE SYNCHRONIZATION SHIFT
S210
SEND SYNCHRONIZATION INFORMATION
END

FIG. 9

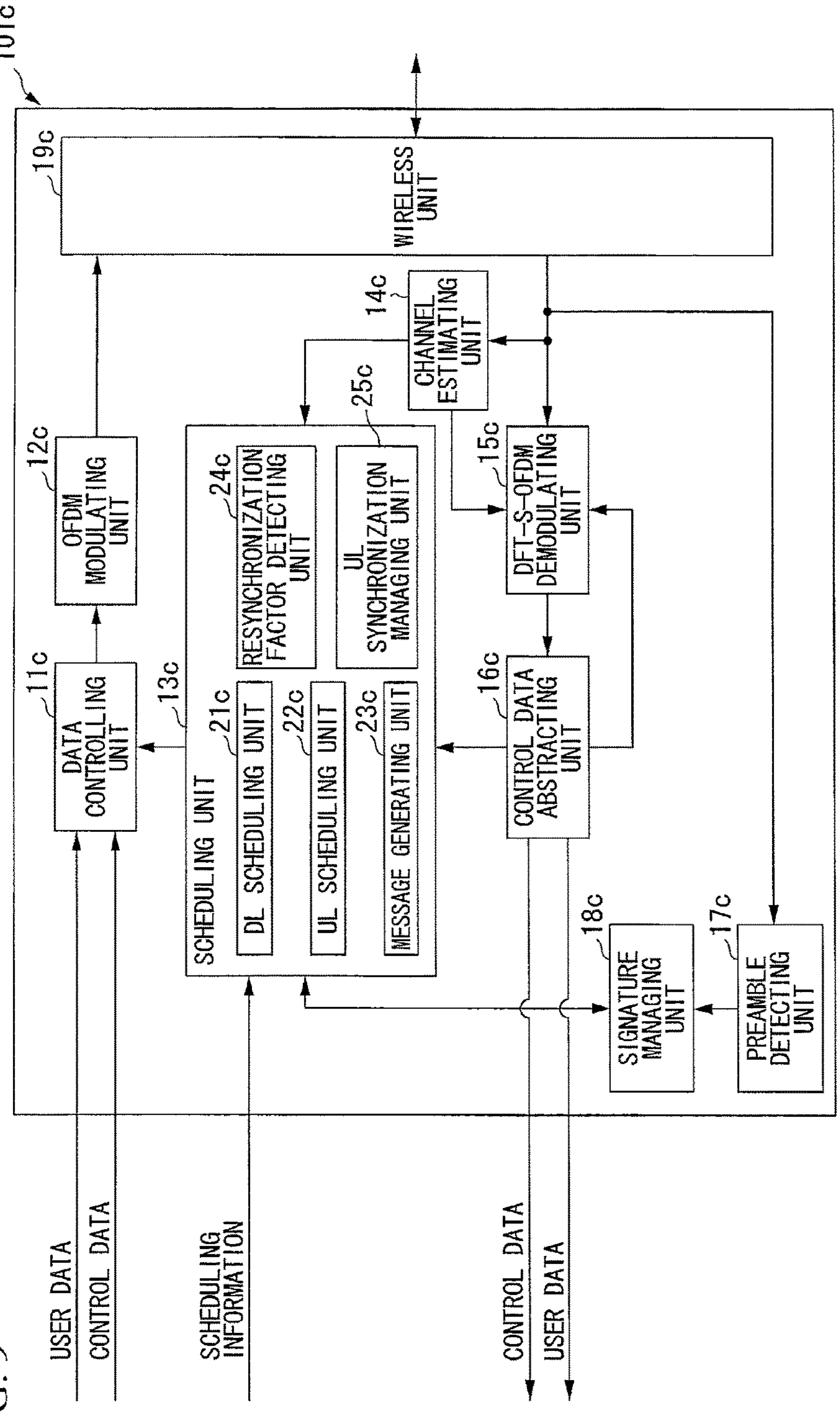
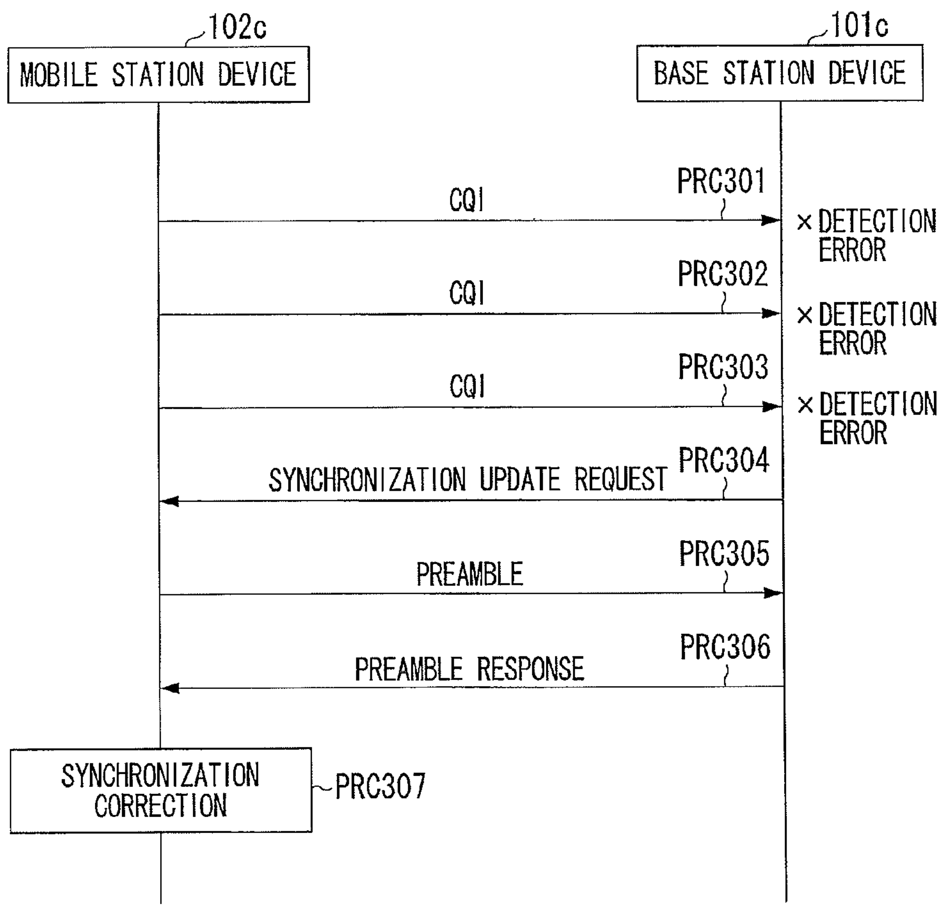
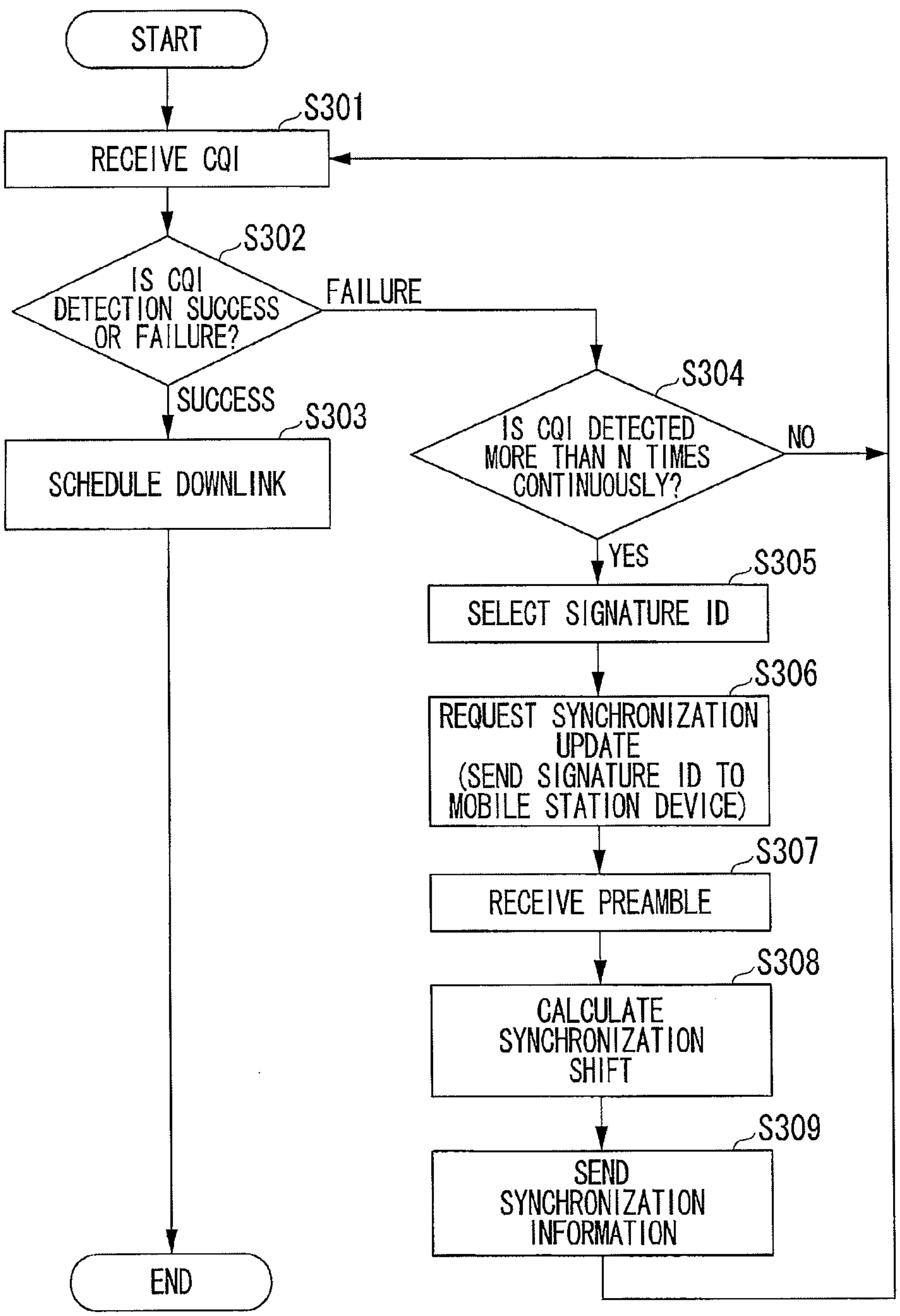

101c
19c
WIRELESS UNIT
14c
CHANNEL ESTIMATING UNIT
12c
OFDM MODULATING UNIT
25c
24c
RESYNCHRONIZATION FACTOR DETECTING UNIT
UL SYNCHRONIZATION MANAGING UNIT
15c
DFT-S-OFDM DEMODULATING UNIT
11c
DATA CONTROLLING UNIT
13c
21c
22c
23c
SCHEDULING UNIT
DL SCHEDULING UNIT
UL SCHEDULING UNIT
MESSAGE GENERATING UNIT
16c
CONTROL DATA ABSTRACTING UNIT
18c
SIGNATURE MANAGING UNIT
17c
PREAMBLE DETECTING UNIT
USER DATA
CONTROL DATA
SCHEDULING INFORMATION
CONTROL DATA
USER DATA

FIG. 10



102c
MOBILE STATION DEVICE
101c
BASE STATION DEVICE
CQI
PRC301
×DETECTION ERROR
CQI
PRC302
×DETECTION ERROR
CQI
PRC303
×DETECTION ERROR
SYNCHRONIZATION UPDATE REQUEST
PRC304
PREAMBLE
PRC305
PREAMBLE RESPONSE
PRC306
SYNCHRONIZATION CORRECTION
PRC307

FIG. 11


START
S301
RECEIVE CQI
S302
IS CQI DETECTION SUCCESS OR FAILURE?
FAILURE
SUCCESS
S303
SCHEDULE DOWNLINK
S304
IS CQI DETECTED MORE THAN N TIMES CONTINUOUSLY?
NO
YES
S305
SELECT SIGNATURE ID
S306
REQUEST SYNCHRONIZATION UPDATE (SEND SIGNATURE ID TO MOBILE STATION DEVICE)
S307
RECEIVE PREAMBLE
S308
CALCULATE SYNCHRONIZATION SHIFT
S309
SEND SYNCHRONIZATION INFORMATION
END

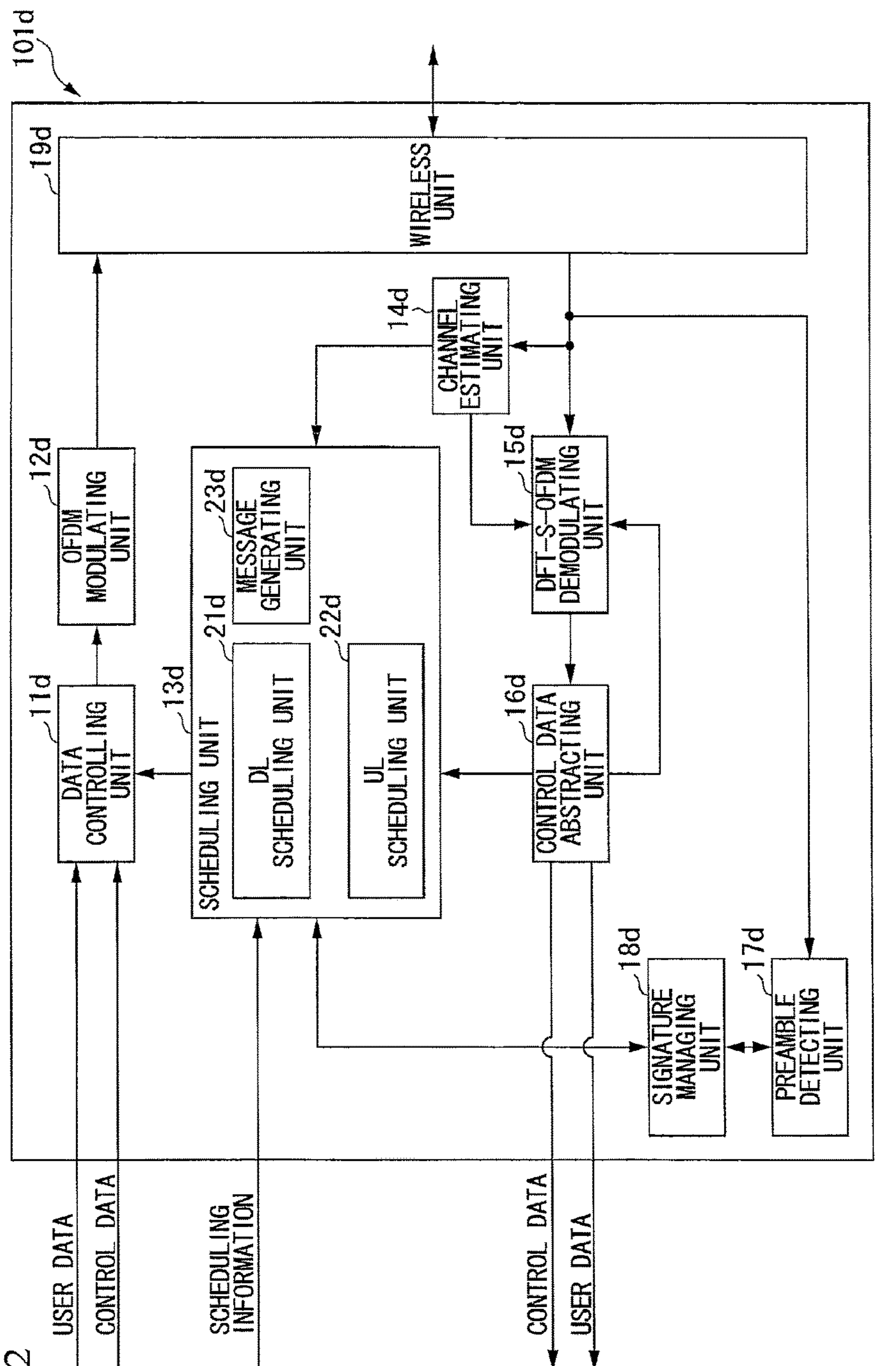

101d
19d
WIRELESS UNIT
14d
CHANNEL ESTIMATING UNIT
12d
OFDM MODULATING UNIT
23d
MESSAGE GENERATING UNIT
15d
DFT-S-OFDM DEMODULATING UNIT
11d
DATA CONTROLLING UNIT
13d
SCHEDULING UNIT
21d
DL SCHEDULING UNIT
22d
UL SCHEDULING UNIT
16d
CONTROL DATA ABSTRACTING UNIT
18d
SIGNATURE MANAGING UNIT
17d
PREAMBLE DETECTING UNIT
USER DATA
CONTROL DATA
SCHEDULING INFORMATION
CONTROL DATA
USER DATA

FIG. 12

FIG. 13

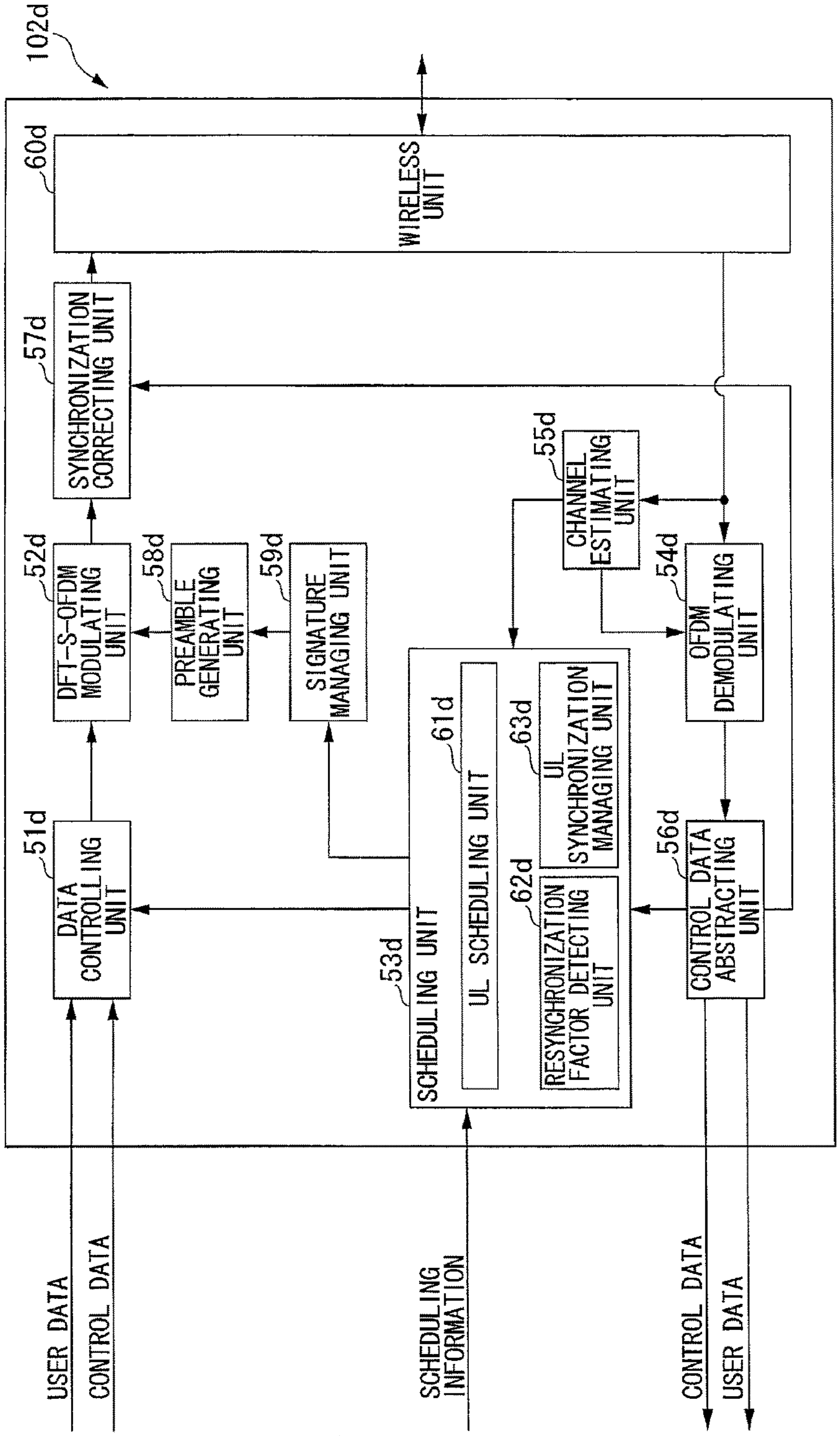

102d
60d
WIRELESS UNIT
57d
SYNCHRONIZATION CORRECTING UNIT
52d
DFT-S-OFDM MODULATING UNIT
58d
PREAMBLE GENERATING UNIT
59d
SIGNATURE MANAGING UNIT
55d
CHANNEL ESTIMATING UNIT
54d
OFDM DEMODULATING UNIT
51d
DATA CONTROLLING UNIT
53d
SCHEDULING UNIT
61d
UL SCHEDULING UNIT
62d
RESYNCHRONIZATION FACTOR DETECTING UNIT
63d
UL SYNCHRONIZATION MANAGING UNIT
56d
CONTROL DATA ABSTRACTING UNIT
USER DATA
CONTROL DATA
SCHEDULING INFORMATION
CONTROL DATA
USER DATA

FIG. 14

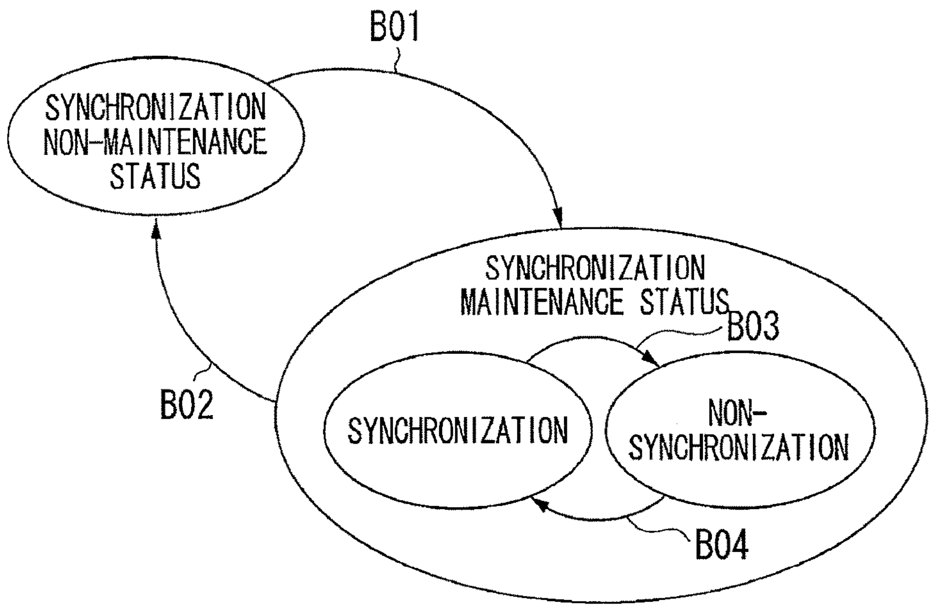

B01
SYNCHRONIZATION NON-MAINTENANCE STATUS
SYNCHRONIZATION MAINTENANCE STATUS
B03
B02
SYNCHRONIZATION
NON-SYNCHRONIZATION
B04

FIG. 15

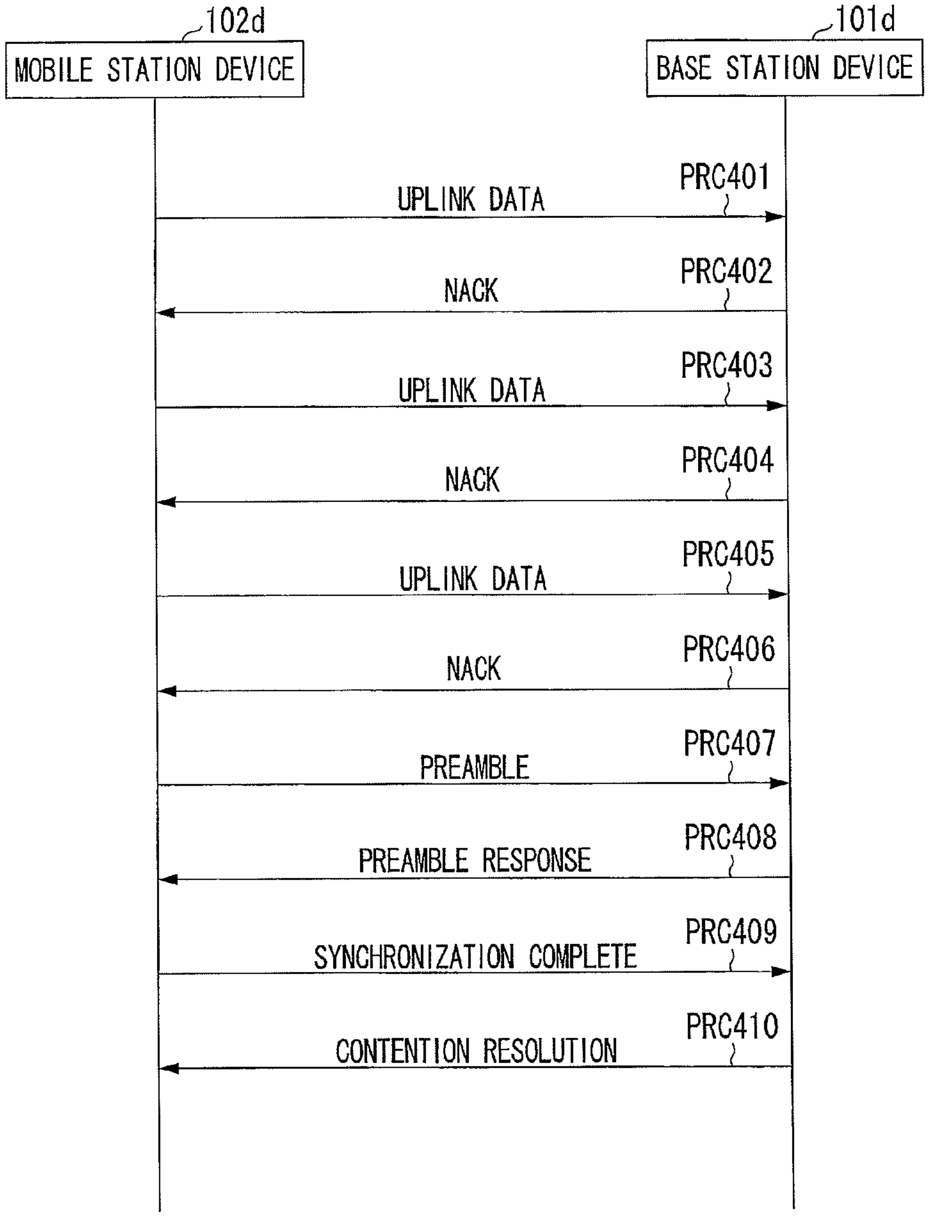

102d
MOBILE STATION DEVICE
101d
BASE STATION DEVICE
PRC401
UPLINK DATA
PRC402
NACK
PRC403
UPLINK DATA
PRC404
NACK
PRC405
UPLINK DATA
PRC406
NACK
PRC407
PREAMBLE
PRC408
PREAMBLE RESPONSE
PRC409
SYNCHRONIZATION COMPLETE
PRC410
CONTENTION RESOLUTION

FIG. 16

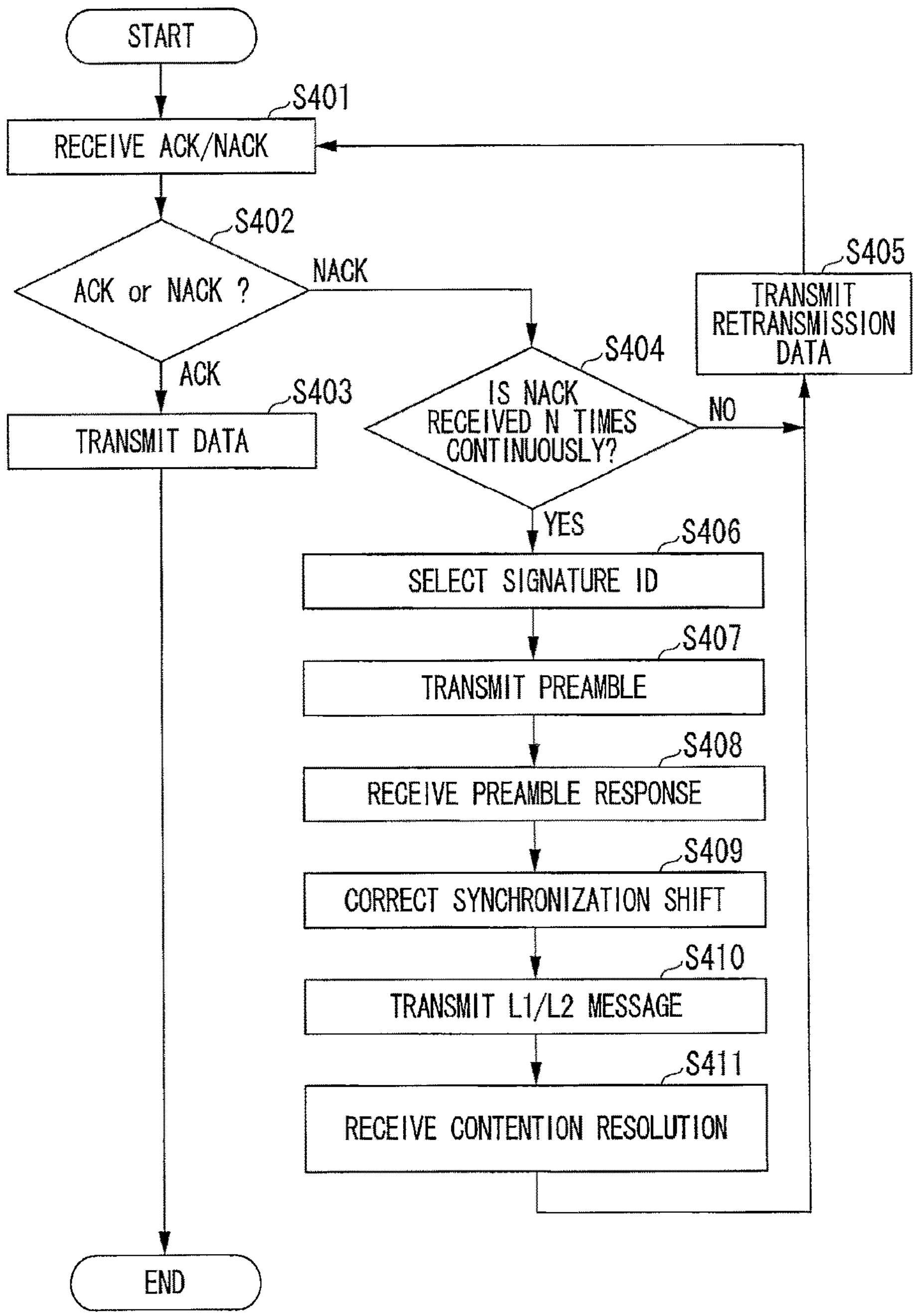
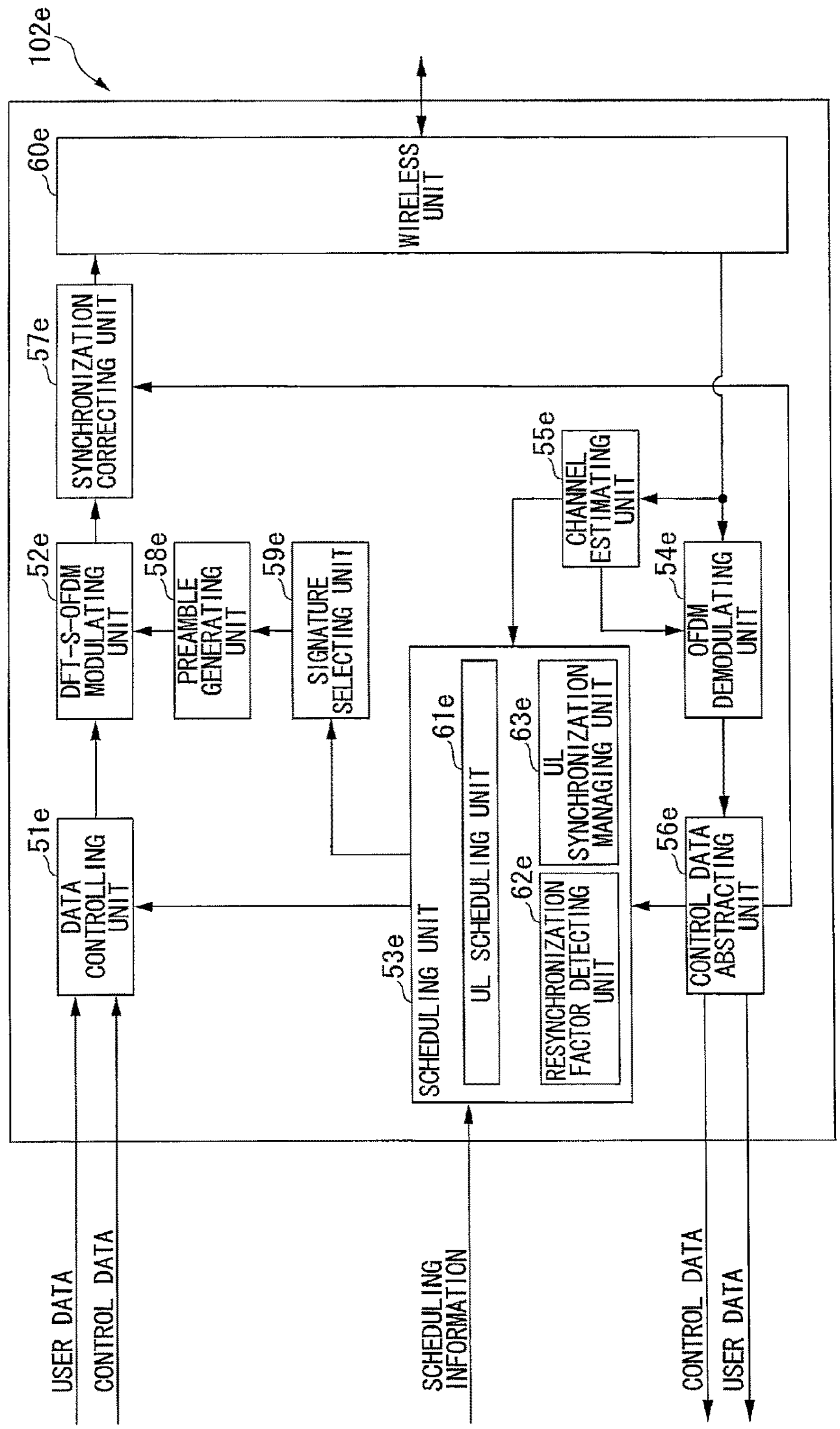

START
RECEIVE ACK/NACK
S401
ACK or NACK ?
S402
NACK
ACK
TRANSMIT DATA
S403
IS NACK RECEIVED N TIMES CONTINUOUSLY?
S404
NO
YES
TRANSMIT RETRANSMISSION DATA
S405
SELECT SIGNATURE ID
S406
TRANSMIT PREAMBLE
S407
RECEIVE PREAMBLE RESPONSE
S408
CORRECT SYNCHRONIZATION SHIFT
S409
TRANSMIT L1/L2 MESSAGE
S410
RECEIVE CONTENTION RESOLUTION
S411
END

FIG. 17



102e
60e
WIRELESS UNIT
57e
SYNCHRONIZATION CORRECTING UNIT
55e
CHANNEL ESTIMATING UNIT
52e
DFT-S-OFDM MODULATING UNIT
58e
PREAMBLE GENERATING UNIT
59e
SIGNATURE SELECTING UNIT
54e
OFDM DEMODULATING UNIT
61e
UL SCHEDULING UNIT
63e
UL SYNCHRONIZATION MANAGING UNIT
51e
DATA CONTROLLING UNIT
53e
SCHEDULING UNIT
62e
RESYNCHRONIZATION FACTOR DETECTING UNIT
56e
CONTROL DATA ABSTRACTING UNIT
USER DATA
CONTROL DATA
SCHEDULING INFORMATION
CONTROL DATA
USER DATA

FIG. 18

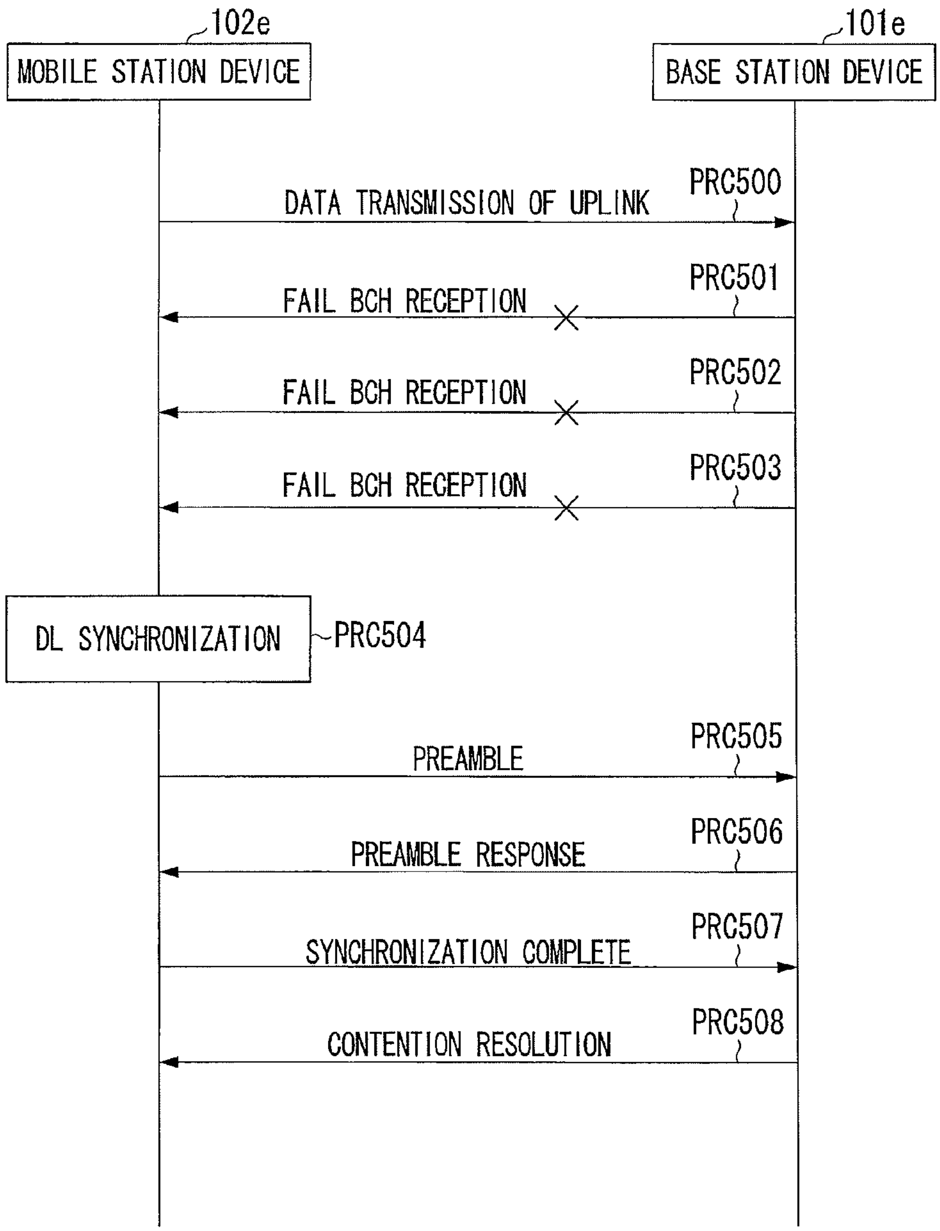
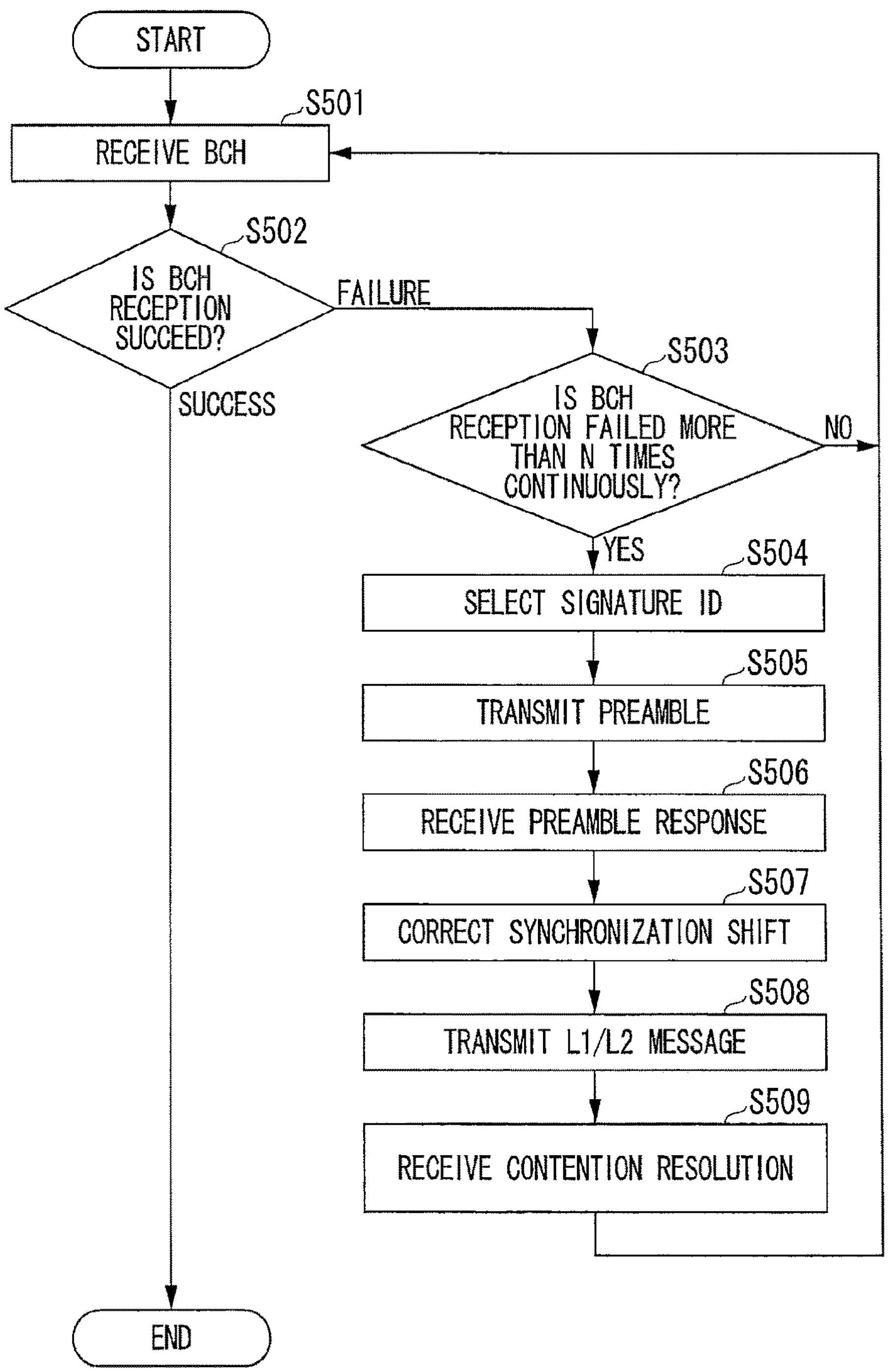

102e
MOBILE STATION DEVICE
101e
BASE STATION DEVICE
DATA TRANSMISSION OF UPLINK
PRC500
FAIL BCH RECEPTION
PRC501
FAIL BCH RECEPTION
PRC502
FAIL BCH RECEPTION
PRC503
DL SYNCHRONIZATION
PRC504
PREAMBLE
PRC505
PREAMBLE RESPONSE
PRC506
SYNCHRONIZATION COMPLETE
PRC507
CONTENTION RESOLUTION
PRC508

FIG. 19


START
S501
RECEIVE BCH
S502
IS BCH RECEPTION SUCCEED?
FAILURE
SUCCESS
S503
IS BCH RECEPTION FAILED MORE THAN N TIMES CONTINUOUSLY?
NO
YES
S504
SELECT SIGNATURE ID
S505
TRANSMIT PREAMBLE
S506
RECEIVE PREAMBLE RESPONSE
S507
CORRECT SYNCHRONIZATION SHIFT
S508
TRANSMIT L1/L2 MESSAGE
S509
RECEIVE CONTENTION RESOLUTION
END

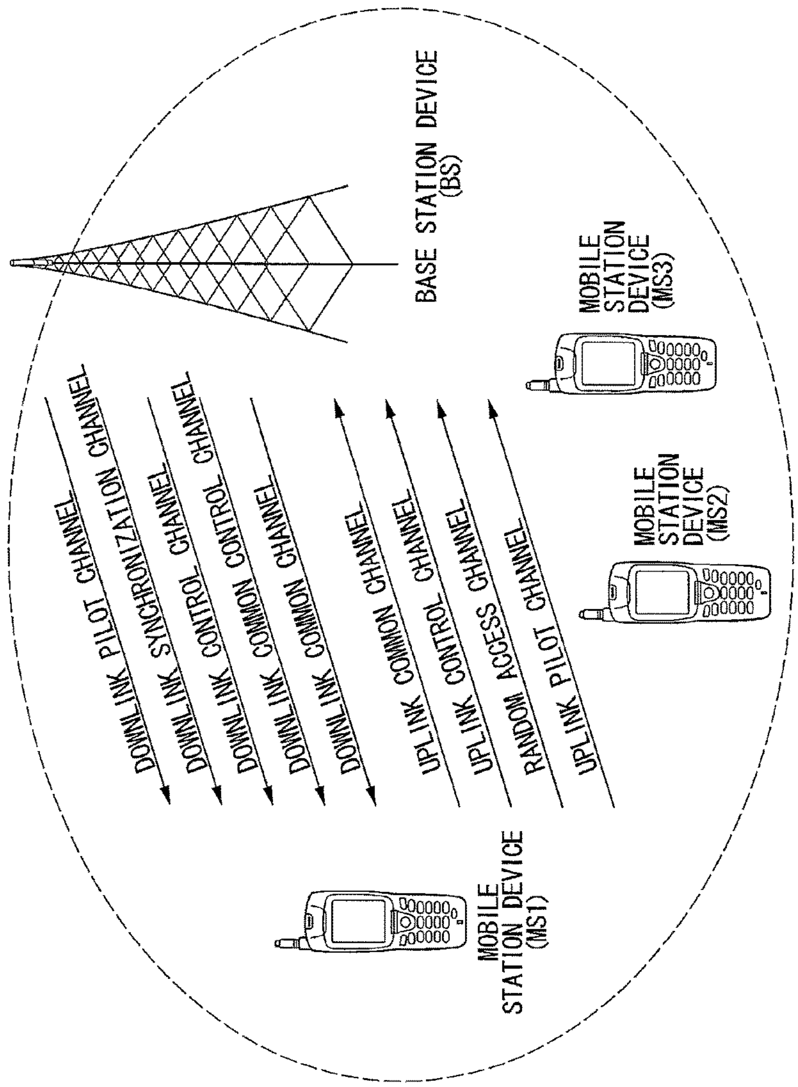

BASE STATION DEVICE (BS)
MOBILE STATION DEVICE (MS3)
MOBILE STATION DEVICE (MS2)
MOBILE STATION DEVICE (MS1)
DOWNLINK PILOT CHANNEL
DOWNLINK SYNCHRONIZATION CHANNEL
DOWNLINK CONTROL CHANNEL
DOWNLINK COMMON CONTROL CHANNEL
DOWNLINK COMMON CHANNEL
DOWNLINK COMMON CHANNEL
UPLINK COMMON CHANNEL
UPLINK CONTROL CHANNEL
RANDOM ACCESS CHANNEL
UPLINK PILOT CHANNEL

FIG. 20

FIG. 21

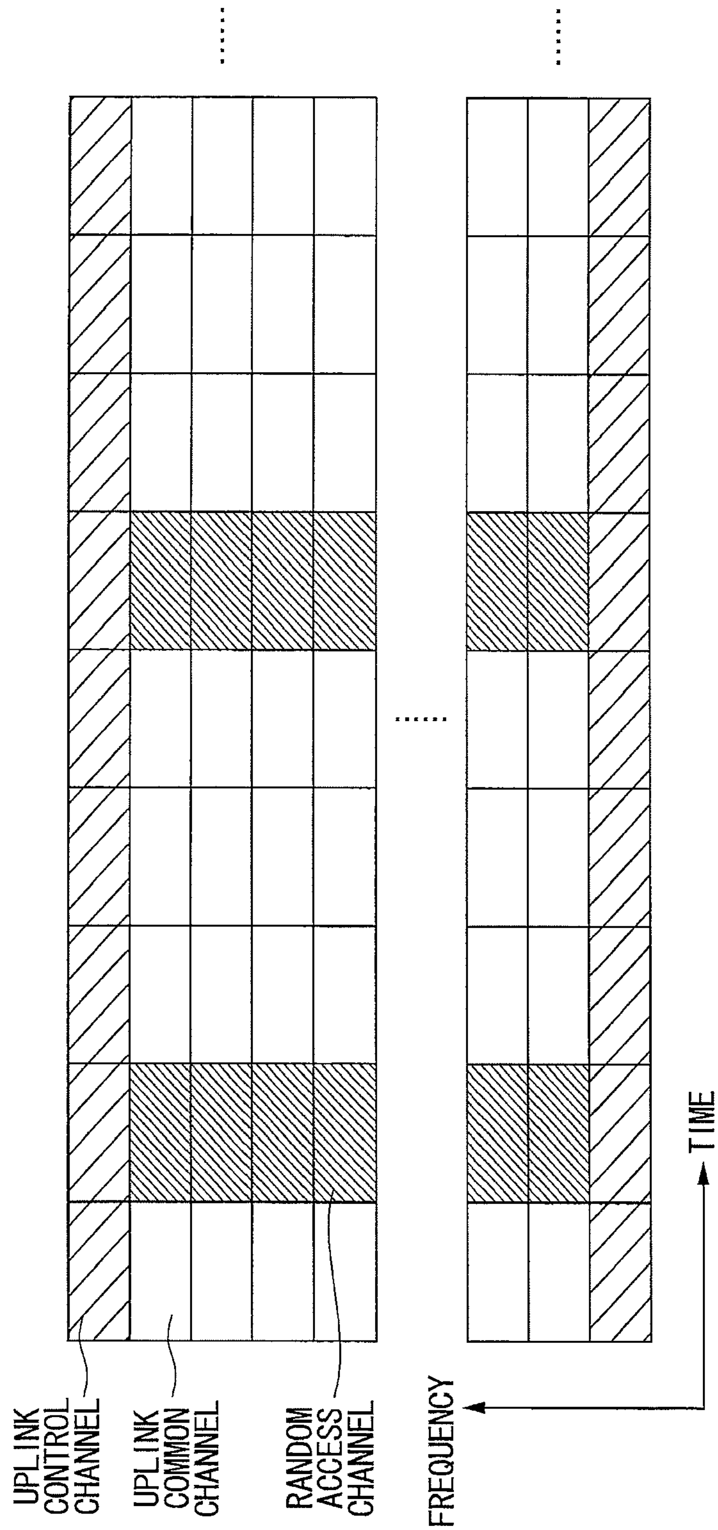

UPLINK CONTROL CHANNEL
UPLINK COMMON CHANNEL
RANDOM ACCESS CHANNEL
FREQUENCY
TIME

FIG. 22

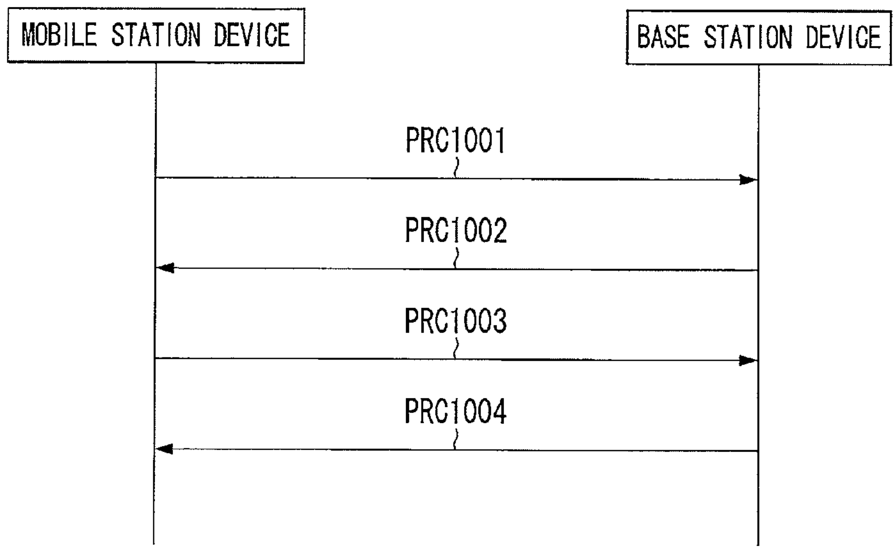

MOBILE STATION DEVICE
BASE STATION DEVICE
PRC1001
PRC1002
PRC1003
PRC1004

FIG. 23

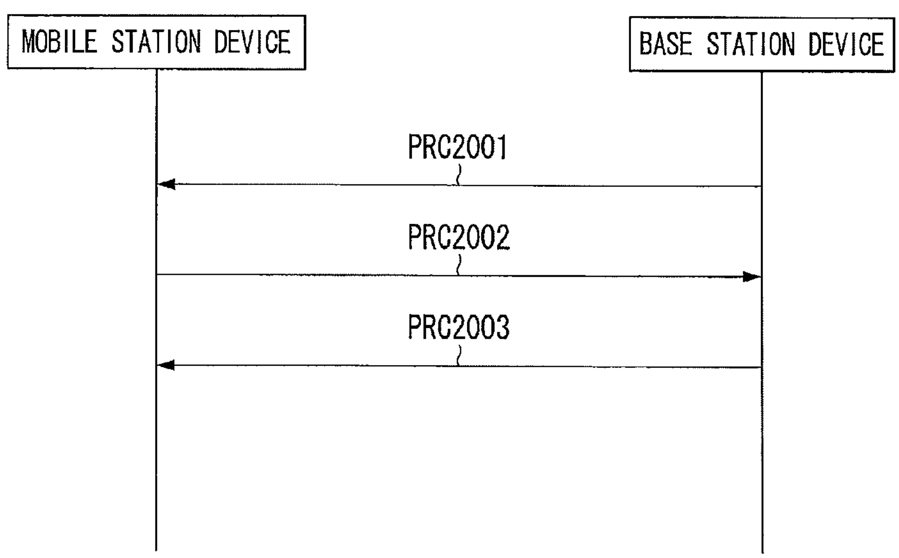

MOBILE STATION DEVICE
BASE STATION DEVICE
PRC2001
PRC2002
PRC2003

FIG. 24

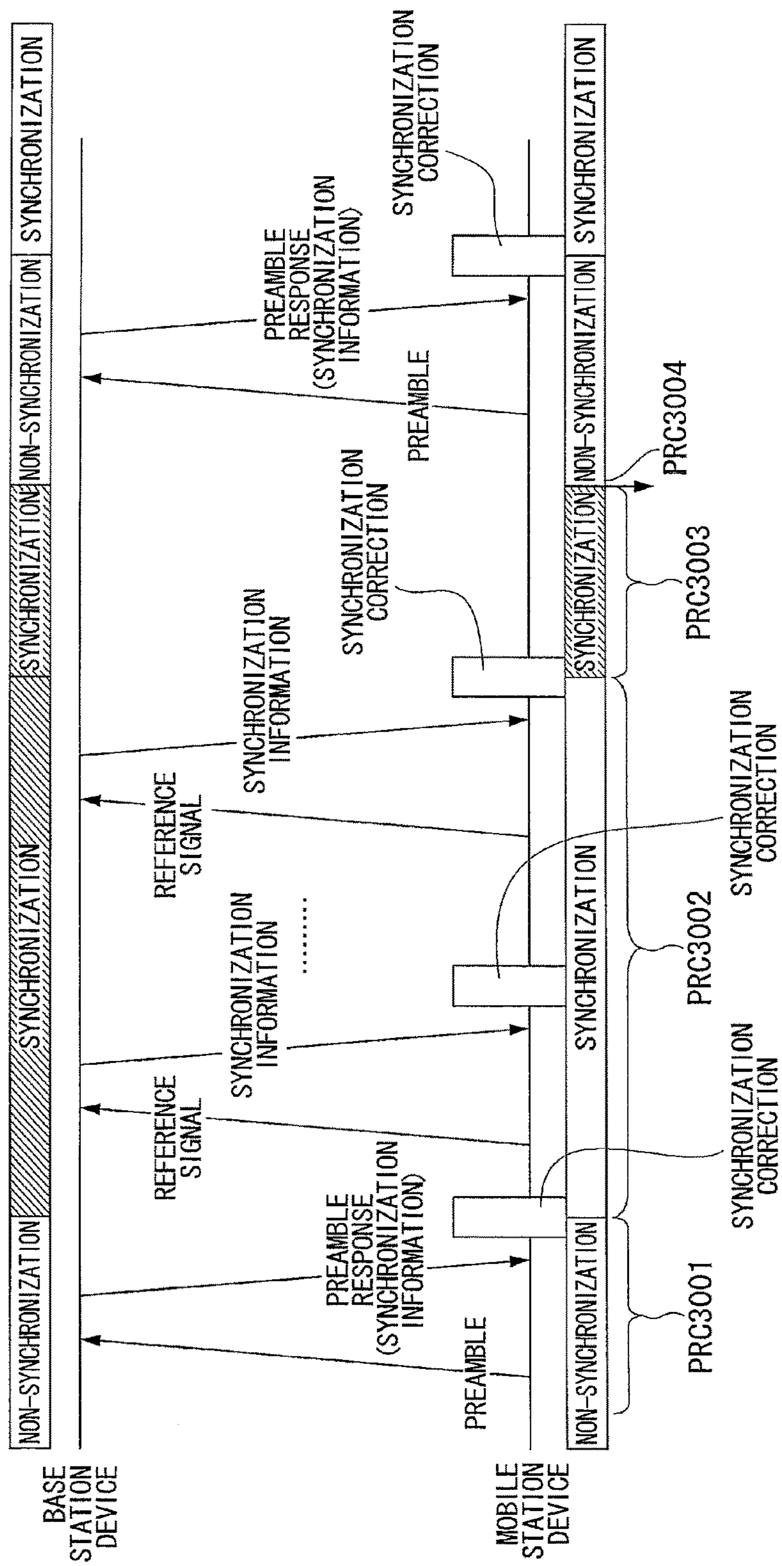

BASE STATION DEVICE
MOBILE STATION DEVICE
NON-SYNCHRONIZATION
SYNCHRONIZATION
SYNCHRONIZATION
NON-SYNCHRONIZATION
NON-SYNCHRONIZATION
SYNCHRONIZATION
PREAMBLE
PREAMBLE RESPONSE (SYNCHRONIZATION INFORMATION)
REFERENCE SIGNAL
SYNCHRONIZATION INFORMATION
SYNCHRONIZATION CORRECTION
PRC3001
PRC3002
PRC3003
PRC3004

FIG. 25

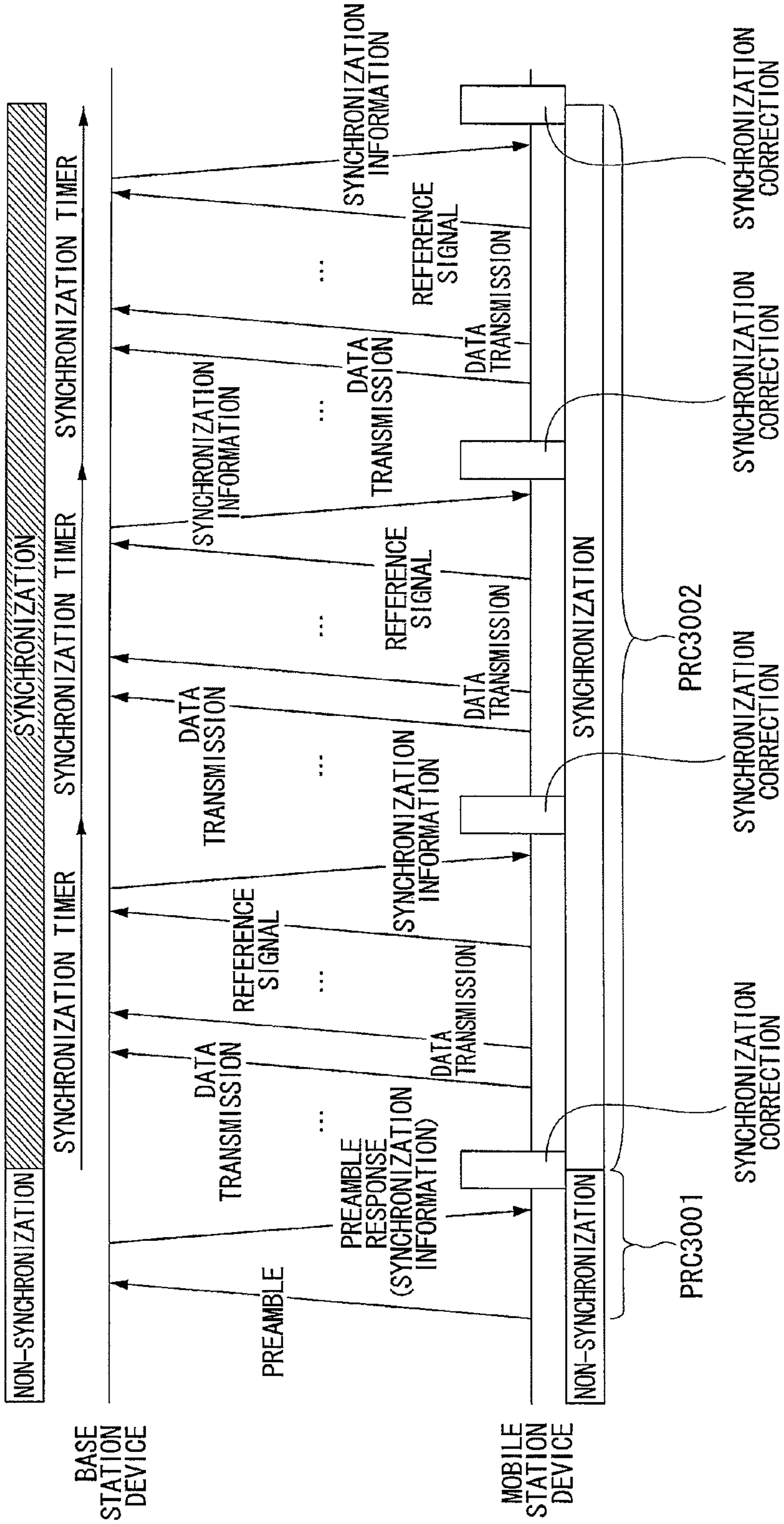
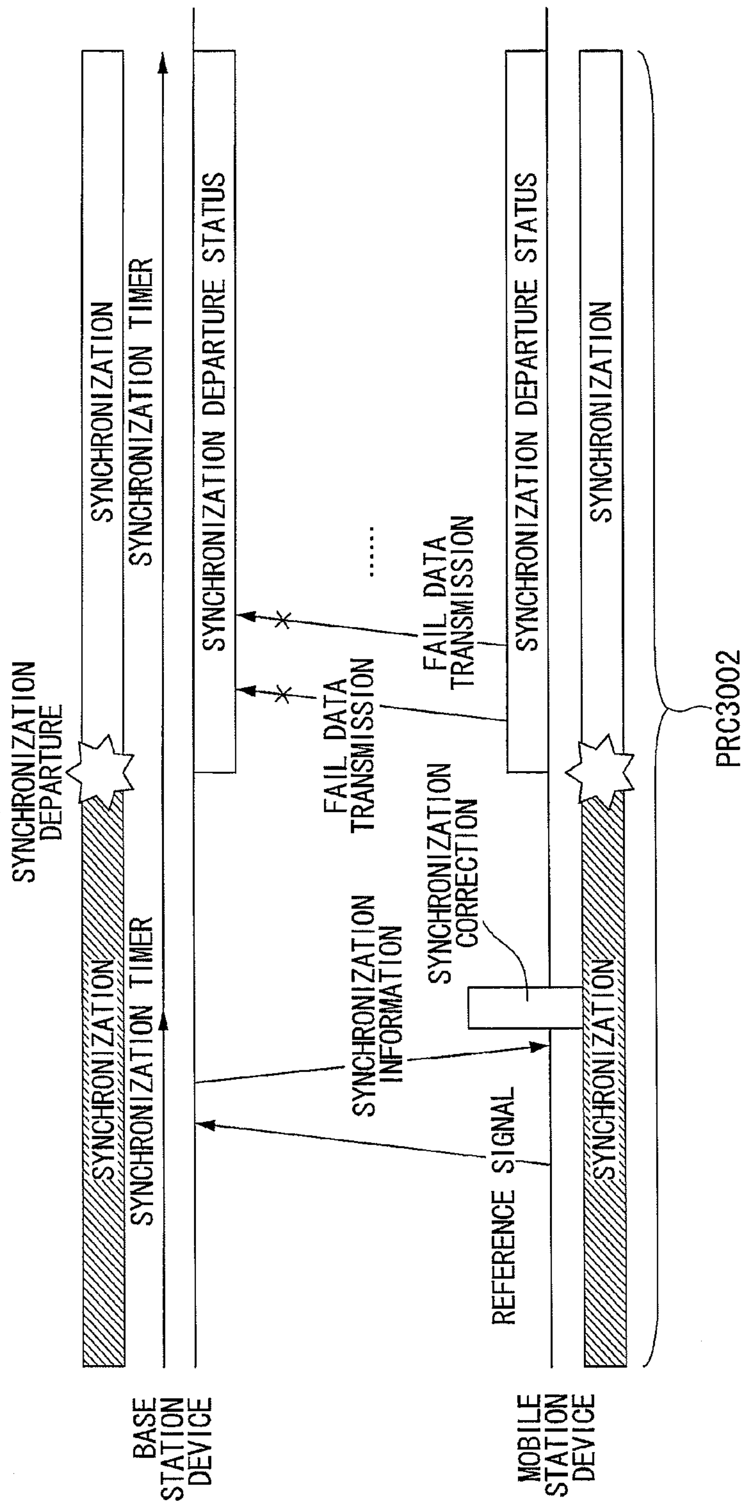

BASE STATION DEVICE
MOBILE STATION DEVICE
NON-SYNCHRONIZATION
SYNCHRONIZATION
SYNCHRONIZATION TIMER
SYNCHRONIZATION TIMER
SYNCHRONIZATION TIMER
PREAMBLE
PREAMBLE RESPONSE (SYNCHRONIZATION INFORMATION)
DATA TRANSMISSION
DATA TRANSMISSION
REFERENCE SIGNAL
SYNCHRONIZATION INFORMATION
DATA TRANSMISSION
DATA TRANSMISSION
REFERENCE SIGNAL
SYNCHRONIZATION INFORMATION
DATA TRANSMISSION
DATA TRANSMISSION
REFERENCE SIGNAL
SYNCHRONIZATION INFORMATION
NON-SYNCHRONIZATION
SYNCHRONIZATION
SYNCHRONIZATION CORRECTION
SYNCHRONIZATION CORRECTION
SYNCHRONIZATION CORRECTION
SYNCHRONIZATION CORRECTION
PRC3001
PRC3002

FIG. 26


BASE STATION DEVICE
MOBILE STATION DEVICE
SYNCHRONIZATION
SYNCHRONIZATION TIMER
SYNCHRONIZATION DEPARTURE
SYNCHRONIZATION DEPARTURE STATUS
REFERENCE SIGNAL
SYNCHRONIZATION INFORMATION
SYNCHRONIZATION CORRECTION
FAIL DATA TRANSMISSION
FAIL DATA TRANSMISSION
......
PRC3002

BASE STATION DEVICE, MOBILE STATION DEVICE, COMMUNICATION SYSTEM AND COMMUNICATION METHOD

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a Reissue of U.S. Pat. No. 8,396,032, issued on Mar. 12, 2013, which is the National Phase of PCT International Application No. PCT/JP2008/054757 filed on Mar. 14, 2008, which claims the benefit under 35 U.S.C. § 119(a) to Patent Application No. 2007-161020, filed in Japan on Jun. 19, 2007, all of which are hereby expressly incorporated by reference into the present application.

TECHNICAL FIELD

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

Priority is claimed on Japanese Patent Application No. 2007-161020, filed Jun. 19, 2007, the contents of which are incorporated herein by reference.

BACKGROUND ART

In 3GPP (3rd Generation Partnership Project), W-CDMA (Wideband Code Division Multiple Access) is standardized as a third generation cellular mobile communication system. Then, W-CDMA's service is sequentially started. In addition, HSDPA (High Speed Downlink Packet Access) which has further increased communication speed, is also standardized. Then, HSDPA's service will be started.

In the 3GPP, the evolution of third generation wireless access (EUTRA: Evolved Universal Terrestrial Ratio Access) is discussed.

In a downlink of the EUTRA, an OFDM (Orthogonal Frequency Division Multiplexing) system is proposed. In addition, as an uplink of the EUTRA, a single carrier communication system of a DFT (Discrete Fourier Transform)-spread OFDM system is proposed.

As shown in FIG. **20**, a base station BS performs wireless communications with a plurality of mobile station devices MS**1**, MS**2** and MS**3**. The downlink of the EUTRA includes a downlink pilot channel DPich, a downlink synchronization channel DSCH, a physical downlink control channel PDCCH, a physical downlink shared channel PDSCH and a common control physical channel CCPCH.

The uplink of the EUTRA includes an uplink pilot channel UPiCH, a random access channel RACH, a physical uplink shared channel PUSCH and a physical uplink control channel PUCCH (Non-Patent Documents 1 and 2).

As the random access channel RACH, there are a non-synchronization random access channel and a synchronization random access channel. A minimum unit of the non-synchronization random access channel uses 1.25 MHz band, prepares a plurality of channels for access, and copes with a plurality of accesses. FIG. **21** is one example.

In FIG. **21**, the horizontal axis is time, and the longitudinal axis is frequency. FIG. **21** represents one communication frame of the uplink. The frame is divided into a plurality of resource blocks. One resource block comprises 1 ms of time and 1.25 band of frequency. The random access channel is assigned to the resource blocks shown in the left-diagonal-line-hatched regions. The uplink common channel is assigned to the resource blocks which shown in the blank regions. The uplink control channel is assigned to the resource blocks which shown in the right-diagonal-line-hatched regions.

A purpose of the non-synchronization random access channel is to synchronize the mobile station device and the base station device, and it is possible to shorten the connection time by transmitting a few bits which are a scheduling request for assigning wireless resources. In addition, a purpose of the synchronization random access is to request scheduling (Non-Patent Document 2).

As a non-synchronization access, there are two access methods (a contention based random access and a non-contention base random access). The contention based random access is random access which may cause contention between mobile station devices, is usually performed. The non-contention based random access is random access which does not cause contention, and is performed in a special case for rapidly synchronizing the mobile station device and the base station device by a instruction of the base station device.

In non-synchronization random access, a preamble is only transmitted for synchronizing an uplink. The preamble includes a signature which is a signal pattern representing information, and is able to represent few bit information by using dozens of signatures. If six bit information is transmitted, 64 kinds of signatures are used.

In the six bit information, five bits are assigned a random ID (Identity), and rest one bit is assigned information (for example, pass loss, CQI (Channel Quality Indicator of downlink)) (Non-Patent Document 3).

FIG. **22** is a processes of the contention random access of the non-synchronization random access.

First, the mobile station device selects a signature among a random ID, a pass loss/CQI of downlink, and transmits a random access preamble using the non-synchronization random access channel of downlink (process PRC **1001**). When the base station device receives the preamble from the mobile station device, the base station device calculates a synchronization timing shift between the mobile station device and the base station device based on the preamble. Then the base station device performs scheduling for transmitting a L2/L3 (Layer 2/Layer 3). Then the base station device assigns a temporary C-RNTI to the mobile station device which needs C-RNTI (Cell-Ratio Network Temporary Identity) based on a random access reason in the random access preamble. Then the base station device transmits synchronization timing shift information, scheduling information, and a random access response which includes the C-RNTI and a signature ID number (process PRC **1002**).

The mobile station device abstracts response of the base station which includes transmitted a signature ID. Then, the mobile station device transmits the L2/L3 message using wireless recourse scheduled based on the scheduling information (process PRC **1003**). The base station device receives the L2/L3 message form the mobile station device, and transmits, to the mobile station device, a contention resolution for determining whether or not contention has occurred between mobile station devices (process PRC **1004**). This technology is disclosed in the Non-Patent Document 3.

FIG. **23** shows processes of non-contention random access of the non-synchronization random access.

First, the base station device selects a signature and transmits it to the mobile station device (process PRC **2001**). The mobile station device transmits a random access preamble on a non-synchronization random access channel using a sent signature (process PRC **2002**). The base station device calculates the synchronization timing shift between the mobile station device and the base station device when the base station device receives the preamble from the mobile station device, and transmits a random access response which includes a C-RNTI or an RA-RNTI (Random Access-Radio Network Temporary Identity) (process PRC **2003**). The mobile station device corrects the synchronization timing shift based on the received message 3 (Non-Patent Document 3). The C-RNTI or RA-RNTI is one kind of identification.

As the uplink pilot channel UPiCH, there are two kind of reference signals. In other words, there is a reference signal which is used for measuring (sounding Reference Signal) and a reference signal for demodulating (demodulated Reference signal). The reference signal which is used for measuring is used as a reference signal which estimates a channel for scheduling of an uplink. The reference signal which is used for measuring is used to perform data scheduling. Therefore, the reference signal which is used for measuring is assigned a wide transmission band which is wider than a band of data transmission, and is regularly and separately transmitted from data transmission. The reference signal which is used for measuring is described later.

The reference signal for demodulating is used as a reference signal which estimates a channel for scheduled data demodulation. The reference signal for demodulating is used to perform data demodulation. Therefore the reference signal for demodulating is only transmitted in a transmission band which is same as a band of data.

The uplink pilot channel UPiCH may be used to perform synchronization maintenance of an uplink between a mobile station device which transmits data in the uplink and a base station device. The base station device calculates a synchronization timing shift between the mobile station device and the base station device based on the uplink pilot channel UPiCH like a preamble of the random access channel RACH, and sends the synchronization timing shift information to the mobile station device (Non-Patent Document 4).

FIG. **24** is a diagram showing each state transition of an uplink synchronization establishment, a synchronization maintenance and a synchronization deviation. FIG. **25** is a diagram showing the synchronization maintenance in detail.

First, in FIG. **24**, the mobile station device performs a non-synchronization random access of contention random access, and synchronizes the base station device and the mobile station device of the uplink (process PRC **3001**). While uplink data is transmitted, only the base station device manages the uplink synchronization, and the base station device measures the uplink pilot channel UPiCH (especially, a reference signal which is used for measuring) and calculates a synchronization timing shift, and the uplink synchronization maintained by the base station device sends the synchronization timing shift information to the mobile station device (process PRC **3002**). If data transmission is finished, a synchronization management of the uplink is performed by the base station device and the mobile station device, and the synchronization is maintained for a predetermined period (process PRC **3003**). After the predetermined period is over (process PRC **3004**), the synchronization is deviated, and the mobile station device performs non-synchronization random access again to synchronize (process PRC **3004**).

The uplink control channel PUCCH is used to transmit ACK (Acknowledgment)/NACK (Negative Acknowledgment) for the downlink data, or is used to transmit a CQI of the downlink for a downlink data scheduling.

The retransmission number is decreased by using HARQ (Hybrid Automatic Repeat reQuest) to data packet of the uplink common channel PUSCH, and by increasing error correction ability of retransmission. In common ARQ (Automatic Repeat reQuest), if an error occurs in receiving packet data, the error-containing packet is destroyed, and the retransmission of the same packet is requested. In contrast, high speed hybrid automatic repeat request is a technique for performing the error recovery by storing the error-containing packet and synthesizing the retransmitted packet data. In a high speed hybrid automatic repeat request, there is a chase synthesis and an IR (Incremental Redundancy) synthesis.

Non-Patent Document 1: 3GPP TS (Technical Specification) 36.211, V1.10 (2007-05), Technical Specification Group Radio Access Network, Physical Channel and Modulation (Release 8)

Non-Patent Document 2: 3GPP TS (Technical Specification) 36.212, V1.20 (2007-05), Technical Specification Group Radio Access Network, Multiplexing and channel coding (Release 8)

Non-Patent Document 3: R2-072338 "Update on Mobility, Security, Random Access Procedure, etc", 3GPP TSG RAN WG2 Meeting #58 Kobe, Japan, 7-11 May, 2007

Non-Patent Document 4: 3GPP TR (Technical Report) 25.814, V7.0.0 (2006-06), Physical layer aspects for evolved Universal Terrestrial Radio Access (UTRA)

DISCLOSURE OF INVENTION

Problem to be Solved by the Invention

However, in a conventional technique, which the uplink data is transmitted, the synchronization management of the uplink is only performed in the base station device, and the synchronization updating is performed regularly. As shown in FIG. **25**, changing from the non-synchronization state to the synchronization state is performed by transmitting the preamble from the mobile station device to the base station device and the base station device performs a preamble response.

Hereinafter, after a predetermined time measured by a synchronization timer of the base station device is lapsed, the base station device transmits the synchronization information (information relating to the synchronization timing shift) to the mobile station device. The mobile station device maintains the synchronization by adjusting the data transmitting timing and performing synchronization correction using the synchronization information. The synchronization correction is performed repeatedly, whenever the synchronization timer measures the predetermined time.

In addition, a method of detecting the deviation of uplink synchronization is only performed after the predetermined time has lapsed and after the uplink data is transmitted.

However, as shown in FIG. **26**, by reason of the synchronization deviation during transmission of the uplink data and by various other reasons, there is a case of synchronization deviation of the uplink. In this case, the base station device and the mobile station device do not detect the synchronization deviation, and the transmission of data from the mobile station device fails for a long period time. FIG. **26** represents this case. If the data transmissions from the mobile station device fails repeatedly and the synchronization is not recovered, the synchronization process is not performed while the synchronization timer of the base station device is not measuring the predetermined time. After the predetermined time has lapsed, the base station device and the mobile station device determines detects that wireless link is disconnected, and the mobile station device starts the synchronization process of the downlink (receiving downlink synchronization channel DSCH) or the synchronization process of the uplink. Therefore, the base station device reconnects to the base station device, and the time until transmitting the uplink data is wasted. To prevent this wasted process, it is necessary to provide means for recovering the synchronization early by detecting the deviation of the synchronization of the uplink by the base station device or the mobile station early.

The present invention is created in light of the aforementioned circumstances, and an object thereof is to provide a base station device, a mobile station device, a communication system and a communication method capable of detecting a synchronization deviation by the base station device or the mobile station device early, and recovering from the non-synchronization state to the synchronization state early, if an uplink synchronization is deviated from.

Means for Solving the Problem

(1) According to one aspect of the present invention, there is provided a base station device which communicates with a mobile station device, comprising: an uplink synchronization managing unit which manages uplink synchronization maintenance status of the mobile station device; and a transmitting unit which transmits a synchronization recovery request to the mobile station which is in the uplink synchronization maintenance status.

(2) Moreover, in the above described base station device, further comprising: a signal receiving unit which receives a signal transmitted by the mobile station device; and an uplink resynchronization factor detecting unit which detects an uplink resynchronization factor based on the signal received by the signal receiving unit, wherein the transmitting unit transmits the synchronization recovery request to the mobile station device, when the uplink resynchronization factor is detected.

(3) Moreover, in the above described base station device, wherein the uplink resynchronization factor detecting unit determines that the uplink resynchronization factor is detected, when the signal transmitted by the mobile station device is not normally received.

(4) Moreover, in the above described base station device, wherein the uplink resynchronization factor detecting unit determines that the uplink resynchronization factor is detected, when the number of not receiving a reference signal from the signal transmitted by the mobile station device is over a predetermined number.

(5) Moreover, in the above described base station device, wherein the uplink resynchronization factor detecting unit determines that the uplink resynchronization factor is detected, when the number of not receiving a control signal from the signal transmitted by the mobile station device is over a predetermined number.

(6) Moreover, in the above described base station device, wherein the transmitting unit transmits a retransmission request of the signal to the mobile station device, when the number of measurements by the uplink resynchronization factor detecting unit is less than predetermined number.

(7) According to another aspect of the present invention, there is provided a mobile station device which communicates a base station device, comprising: a signal transmitting unit which transmits a signal to the base station device; a synchronization recovery request receiving unit receives a synchronization recovery request transmitted by the base station device; and a synchronization signal transmitting unit which transmits a synchronization signal to the base station device, when the synchronization recovery request receiving unit receives the synchronization recovery request.

(8) Moreover, in the above described mobile station device, further comprising: a retransmission request receiving unit which receives a retransmission request transmitted by the base station device; and a signal retransmitting unit which retransmits the signal transmitted by the signal transmitting unit to the base station, when the retransmission request receiving unit receives the retransmission request.

(9) According to another aspect of the present invention, there is provided a mobile station device which communicates to a base station device, comprising: an uplink synchronization managing unit which manages an uplink synchronization maintenance status of the mobile station device; and a transmitting unit which transmits a synchronization signal to the base station device, when a status is the uplink synchronization maintenance status.

(10) Moreover, in the above described mobile station device, further comprising: a signal receiving unit which receives the signal transmitted by the base station device; and an uplink resynchronization factor detecting unit which detects the uplink resynchronization factor based on the signal received by the signal receiving unit, wherein the transmitting unit transmits the synchronization signal to the base station device, when the uplink resynchronization factor is detected.

(11) Moreover, in the above described mobile station device, wherein the uplink resynchronization detecting unit determines that the uplink resynchronization factor is detected, when the number of determining the signal transmitted by the base station device as retransmission request is over predetermined number.

(12) Moreover, in the above described mobile station device, wherein the uplink resynchronization factor detecting unit determines that the uplink resynchronization factor is being detected, when the number of determining the signal transmitted by the base station as the signal which indicates that the signal is not able to receive is over predetermined number.

(13) Moreover, in the above described mobile station device, wherein the uplink resynchronization factor detecting unit determines that the uplink resynchronization factor is detected, when the number of not detecting the signal of a broadcast channel from the signal transmitted by the base station device is over predetermined number.

(14) According to another aspect of the present invention, there is provided a communication system which comprises a base station device and a mobile station device, the base station device comprising: an uplink synchronization managing unit which manages an uplink synchronization maintenance status of the mobile station device; and a transmitting unit which transmits a synchronization recovery request to the mobile station device which is in the uplink synchronization maintenance status, the mobile station device comprising: a signal transmitting unit which transmits a signal to the base station; a synchronization recovery request receiving unit which receives the synchronization recovery request

transmitted by the base station device; and a synchronization signal transmitting unit which transmits the synchronization signal to the base station device, when the synchronization recovery request receiving unit receives the synchronization recovery request.

(15) According to another aspect of the present invention, there is provided a communication method using a base station device and a mobile station device, the base station device comprising: an uplink synchronization managing step which manages an uplink synchronization maintenance status of the mobile station device; and a transmitting step which transmits a synchronization recovery request to the mobile station device which is in the uplink synchronization maintenance status, the mobile station device comprising: a signal transmitting step which transmits a signal to the base station; a synchronization recovery request receiving step which receives the synchronization recovery request transmitted by the base station device; and a synchronization signal transmitting step which transmits the synchronization signal to the base station device, when the synchronization recovery request receiving step receives the synchronization recovery request.

Effect of the Invention

The present invention make is possible to obtain the base station device, the mobile station device, the communication system and the communication method capable of detecting a synchronization deviation by the base station device or the mobile station device early, and recovering from the non-synchronization state to the synchronization state early, if an uplink synchronization is deviated from.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram showing a configuration of a base station device of a communication system according to a first embodiment of the present invention.

FIG. **2** is a state diagram of a UL synchronization managing unit **25**a according to the first embodiment of the present invention.

FIG. **3** is a block diagram showing a configuration of a mobile station device of the communication system according to the first embodiment of the present invention.

FIG. **4** is a sequence diagram showing communication processes of the communication system according to the first embodiment of the present invention.

FIG. **5** is a flowchart showing processes of the base station device of the communication system according to the first embodiment of the present invention.

FIG. **6** is a block diagram showing a configuration of a base station device of a communication system according to a second embodiment of the present invention.

FIG. **7** is a sequence diagram showing communication processes of the communication system according to the second embodiment of the present invention.

FIG. **8** is a flowchart showing processes of the base station device of the communication system according to the second embodiment of the present invention.

FIG. **9** is a block diagram showing a configuration of a base station device of a communication system according to a third embodiment of the present invention.

FIG. **10** is a sequence diagram showing communication processes of the communication system according to the third embodiment of the present invention.

FIG. **11** is a flowchart showing processes of the base station device of the communication system according to the third embodiment of the present invention.

FIG. **12** is a block diagram showing a configuration of a base station device of a communication system according to a fourth embodiment of the present invention.

FIG. **13** is a block diagram showing a configuration of a mobile station device of the communication system according to the fourth embodiment of the present invention.

FIG. **14** is a state diagram of a UL synchronization managing unit **63**d according to the fourth embodiment of the present invention.

FIG. **15** is a sequence diagram showing communication processes of the communication system according to the fourth embodiment of the present invention.

FIG. **16** is a flowchart showing processes of the base station device of the communication system according to the fourth embodiment of the present invention.

FIG. **17** is a block diagram showing a configuration of a mobile station device of the communication system according to a fifth embodiment of the present invention.

FIG. **18** is a sequence diagram showing communication processes of the communication system according to the fifth embodiment of the present invention.

FIG. **19** is a flowchart showing processes of the base station device of the communication system according to the fifth embodiment of the present invention.

FIG. **20** is an explanation diagram of channel configurations of SUTRA.

FIG. **21** is an explanation diagram of random access channel of uplink of E-UTRA.

FIG. **22** is an explanation diagram of processes of contention random access of non-synchronization random access of E-UTRA.

FIG. **23** is an explanation diagram of processes of non-contention random access of non-synchronization random access of E-UTRA.

FIG. **24** is an explanation diagram of state transition of each synchronization establishment, synchronization maintenance and a synchronization deviation of uplink of E-UTRA.

FIG. **25** is an explanation diagram of synchronization maintenance of uplink of E-UTRA.

FIG. **26** is an explanation diagram of synchronization deviation of uplink of E-UTRA.

REFERENCE SYMBOLS

11a to **11**d data controlling unit,
12a to **12**d OFDM modulating unit,
13a to **13**d scheduling unit,
14a to **14**d channel estimating unit,
15a to **15**d DFT-S-OFDM demodulating unit,
16a to **16**d control data abstracting unit,
17a to **17**d preamble detecting unit,
18a to **18**d signature managing unit,
19a to **19**d wireless unit,
21a to **21**d DL scheduling unit,
22a to **22**d UL scheduling unit,
23a to **23**d message generating unit,
24a to **24**c resynchronization factor detecting unit,
25a to **25**c UL synchronization managing unit,
51a, **51**d, **51**e data controlling unit,
52a, **52**d, **52**e DFT-S-OFDM modulating unit,
53a, **53**d, **53**e scheduling unit,
54a, **54**d, **54**e OFDM demodulating unit,
55a, **55**d, **55**e channel estimating unit,

56a, **56**d, **56**e controlling data abstracting unit,
57a, **57**d, **57**e synchronization correcting unit,
58a, **58**d, **58**e preamble generation unit,
59a, **59**d, **59**e signature selecting unit,
60a, **60**d, **60**e wireless unit,
61d, **61**d UL scheduling unit,
62d, **62**e resynchronization factor detecting unit,
63e, **63**e UL synchronization managing unit,
101a to **101**e base station device,
102a to **102**e mobile station device

BEST MODE FOR CARRYING OUT THE INVENTION

First Embodiment

FIG. **1** is a diagram showing a configuration of a base station device **101**a of a communication system according to a first embodiment of the present invention. In FIG. **1**, the base station device **101**a includes a data controlling unit **11**a, an OFDM modulating unit **12**a, a scheduling unit **13**a, a channel estimating unit **14**a, a DFT-S (spread)-OFDM demodulating unit **15**a, a control data abstracting unit **16**a, a preamble detecting unit **17**a, a signature managing unit **18**a, a wireless unit **19**a (also called a signal receiving unit and a transmitting unit). The scheduling unit **13**a includes a DL (Down Link) scheduling unit **21**a, an UP (Up Link) scheduling unit **22**a, a message generating unit **23**a, a resynchronization factor detecting unit **24**a and a UL (Up Link) synchronization managing unit **25**a (also called uplink synchronization managing unit).

The data controlling unit **11**a performs a mapping of control data to the common control channel CCPCH, the downlink synchronization channel DSCH, the downlink pilot channel DPiCH, the downlink common channel PDSCH and the downlink control channel PDCCH by an instruction from the scheduling unit **13**a. The data controlling unit **11**a also performs a mapping of a transmission data for each mobile station device **102**a to the downlink common channel PDSCH.

The OFDM modulating unit **12**a performs serial/parallel conversion for the output signal of the data controlling unit **11**a, performs IFFT (Inverse Fast Fourier Transform), performs CP (Cyclic Prefix) insertion, and performs filtering as an OFDM signal processing. Therefore, an OFDM signal is generated.

The wireless unit **19**a performs up-conversion from OFDM-demodulated data to wireless frequency, and transmits the signal to the mobile station device **102**a via an antenna (not shown). In addition, if the number of measuring by the resynchronization factor detecting unit **25**a of the scheduling unit **13**a is over a predetermined number, the wireless unit **19**a transmits a synchronization recovery request to the mobile station device **102**a. In addition, if the number of measuring by the resynchronization factor detecting unit **25**a is less than the predetermined number, the wireless unit **19**a transmits a retransmission request of the signal to the mobile station device **102**a. In other words, each signal of the synchronization recovery request and the retransmission request are supplied to the data controlling unit **11**a, and are performed a mapping to the downlink common channel or the downlink control channel, and are transmitted to the mobile station device **102**a via the OFDM modulating unit **12**a and the wireless unit **14**a.

In addition, the wireless unit **19**a receives the signal transmitted by the mobile station device **102**a. Specifically, the wireless unit **19**a receives the uplink data transmitted by the mobile station device **102**a, and performs a down-convert to the baseband signal, and supplies the reception data to the DFT-S-OFDM demodulating unit **15**a, the channel estimating unit **14**a and the preamble detecting unit **17**a.

The channel estimating unit **14**a estimates wireless channel characteristics based on the reference signal for demodulating of the uplink pilot channel UPiCH, and supplies the wireless channel estimation result to the DFT-spread OFDM demodulating unit **15**a. The wireless channel estimation result is supplied to the scheduling unit **13**a to schedule the uplink based on a reference signal which is used for measuring of the uplink pilot channel UPiCH. In addition, the synchronization timing shift is calculated by measuring the uplink pilot channel UPiCH regularly, the synchronization timing shift is supplied to the scheduling unit **13**a. Here, the uplink communication system is a single carrier system (for example, DFT-spread OFDM), however, a multi carrier system (for example, OFDM system) may be used.

The control data abstracting unit **16**a confirms whether or not the reception signal includes errors, and sends the confirmed result to the scheduling unit **13**a. If the reception data does not include an error, the reception data is separated into user data and a control data. Among the control data, the control data of layer **2** (for example, the CQI information of the downlink, the ACK/NACK of the downlink) is supplied to the scheduling unit **13**a, and other control data and user data of the layer **3** are supplied to the upper layer. If the reception data includes errors, the reception data is stored to synthesize to the retransmission data. Then, the retransmission data is received, and the reception data including errors are synthesized with the retransmission data.

The scheduling unit **13**a includes a downlink scheduling unit **21**a which performs a scheduling of the downlink, a UL scheduling unit **22**a which performs a scheduling of the uplink, a message generating unit **23**a, a resynchronization factor detecting unit **24**a, and a UL synchronization managing unit **25**a.

The DL scheduling unit **21**a performs a scheduling for mapping the user data and control data to each downlink channel based on the CQI information sent by the mobile station device **102**a (FIG. **3**), data information of each user sent by the upper layer of the base station device, and the control data generated by the message generating unit **23**a.

The UL scheduling unit **22**a performs a scheduling for mapping the user data to the each uplink channels based on the uplink wireless channel estimation result from the channel estimating unit **14**a and a resource assignment request from the mobile station device **102**a.

The message generating unit **23**a generates control data (for example, an ACK/NACK of uplink data, a preamble response message and a synchronization update request message).

If the data reception fails continuously based on the reception data result from the control data abstracting unit **16**a, the resynchronization factor detecting unit **24**a determines that the synchronization of the mobile station device **102**a is deviated from, and sends to the UL synchronization managing unit **25**a that the synchronization has been deviated from.

The resynchronization factor detecting unit **24**a determines whether or not a predetermined condition is fulfilled based on the signal received by the wireless unit **19**a. In the first embodiment, the resynchronization factor detecting unit **24**a determines, as the predetermined condition, whether or not the signal transmitted by the mobile station device **102**a has been received normally. For example, the determination is performed based on whether the decoding of the error correction code is possible or not.

In addition, the resynchronization factor detecting unit **24**a measures the number which the predetermined condition is fulfilled based on the determination result. In the first embodiment, the resynchronization factor detecting unit **24**a measures the number that the signal transmitted by the mobile station device **102**a is not able to normally receive.

The UL synchronization managing unit **25**a manages an uplink synchronization state of the mobile station device **102**a. In addition, it supplies the instruction to assign the signature to the signature managing unit **18**a, and to perform a synchronization update process in the mobile station device **102**a

FIG. **2** is a state diagram of a UL synchronization managing unit **25**a according to the first embodiment of the present invention. The mobile station device **102**a performs a random access to the base station device **101**a. If the base station device **101**a detects (step A**01**) the preamble, the state is changed to the synchronization maintenance state. After the communication between the base station device **101**a and the mobile station device **102**a is finished and a predetermined time has lapsed (after the synchronization timer measures the predetermined time), a state is changed to the synchronization non-maintenance state.

In the synchronization maintenance state, there is a synchronization state and a non-synchronization state. When a state is changed from the step A**01**, the synchronization state of the synchronization maintenance is established. While a state is the synchronization state of the synchronization maintenance state, before measurement by the timer is finished, the uplink pilot channel UPiCH is measured, the synchronization information (information relating to the synchronization timing shift) is transmitted to the mobile station, and the synchronization state is maintained. The resynchronization factor detecting unit **24**a determines that the synchronization is deviated from based on the result of the reception data from the control data abstracting unit **16**a (step A**03**), and the state is changed to the non-synchronization state of the synchronization maintenance state.

If the state changes to the non-synchronization state of the synchronization maintenance state, the instruction for assigning the signature is supplied to the signature managing unit **18**a to perform a synchronization update process, and synchronization update request is transmitted to the mobile station device **102**a. The mobile station device **102**a performs random access using the preamble of the signature ID selected by the base station device **101**a. Then, the preamble of signature ID selected by the base station device is detected by the preamble detecting unit **17**a. If the preamble response is transmitted to the mobile station device (step A**04**), the state is changed to the synchronization state of the synchronization maintenance state.

In addition, the synchronization maintenance state is a state where the base station device **101**a and the mobile station device **102**a communicate with each other and the mobile station device **102**a performs reception of the downlink (including control data) and a transmission of the uplink (including control data), or is a state before the synchronization timer expires.

The preamble detecting unit **17**a detects the preamble transmitted by the mobile station device **102**a (FIG. **3**), and calculates the amount of synchronization timing shift, and reports the signature ID and the amount of synchronization timing shift to the signature managing unit **18**a.

The signature managing unit **18**a selects the signature ID based on the instruction from the scheduling unit **13**a, and sends it to the scheduling unit **13**a. The selection of the signature ID number is performed by confirming the signature ID number which is currently used by the base station device **101**a, and by selecting the signature without currently used signatures.

In addition, the signature managing unit **18**a stores the selected signature ID number as it is currently used. Then the signature managing unit **18**a deletes the stored contents, because the signature ID number which is detected by the preamble detecting unit **17**a and is selected by the base station device **101**a is finished to use. In addition, the signature ID number and the amount of synchronization timing shift are supplied to the scheduling unit **13**a.

FIG. **3** is a block diagram showing a configuration of a mobile station device **102**a of the communication system according to the first embodiment of the present invention. The mobile station device **102**a includes a data controlling unit **51**a, a DFT-S-OFDM modulating unit **52**a, a scheduling unit **53**a, an OFDM demodulating unit **54**a, a channel estimating unit **55**a, a control data abstracting unit **56**a, a synchronization correcting unit **57**a, a preamble generating unit **58**a, a signature selecting unit **59**a and a wireless unit **60**a (also called a signal transmitting unit, a synchronization recovery request receiving unit, a synchronization signal transmitting unit, retransmission receiving unit and a signal retransmitting unit).

The user data and the control data are supplied to the data controlling unit **51**a, the downlink CQI, ACK/NACK are assigned to the uplink control channel PUCCH, and the user data, and the signals excluding the downlink CQI, ACK/NACK are assigned to the uplink common channel based on the instructions from the scheduling unit **53**a and are then transmitted. In addition, the reference signal which is used for measuring and the reference signal for demodulating are assigned to the uplink pilot channel UPiCH.

The DFT-S-OFDM modulating unit **52**a performs data modulation, and the modulated signal performs a DFT conversion, a sub-carrier mapping, an IFFT conversion, a CP (Cyclic Prefix) insertion and a filtering as a DFT-S-OFDM signal processing. Therefore, a DFT-Spread-OFDM signal is generated. Here, the communication system of the uplink uses a single carrier system (for example, DFT-spread OFDM). However, a multi carrier system (for example, OFDM system) may be used.

The synchronization correcting unit **57**a corrects a transmission timing based on the synchronization information outputted from the control data abstracting unit **56**a, the data which is demodulated to match a transmission timing supplied to the wireless unit **60**a.

The wireless unit **60**a transmits a signal to the base station device **101**a (FIG. **1**) via antenna (not shown). Specifically, the wireless unit **60**a sets a wireless frequency instructed by the wireless controlling unit, and performs up-conversion modulated data to wireless frequency, and transmits it to the base station device **101**.

In addition, the wireless unit **60**a receives the downlink data transmitted by the base station device **101**a, performs down-conversion to a baseband signal, and supplies the reception data to the OFDM demodulating unit **54**a.

If the wireless unit **60**a receives the synchronization request from the base station device, the wireless unit **60**a transmits the synchronization signal to the base station device **101**a. If the wireless unit **60**a receives the retransmission request from the base station device **101**a, the wireless unit **60**a retransmits the signal which was transmitted to the base station device **101**a to the base station device **101**a.

The channel estimating unit **55**a estimates wireless channel characteristics based on the downlink pilot channel DPiCH, and supplies the estimated result to the OFDM demodulating unit **54**a. In addition, the channel estimating unit **55**a converts it to the CQI information to send the wireless channel estimation result to the base station device **101**a, and supplies the CQI information to the scheduling unit **53**a.

The OFDM demodulating unit **54**a demodulates the reception data based on the wireless channel estimation result of the channel estimating unit **55**a.

The control data abstracting unit **56**a separates the reception data into user data and control data. Among the control data, the synchronization information of the uplink supplied to the synchronization correcting unit **57**a, the scheduling information, the synchronization update request message, and other layer **2** control data are supplied to the scheduling unit **53**a, and the layer **3** control data and the user data are supplied to the upper layer.

The scheduling unit **53**a controls the data controlling unit **51**a based on the control information outputted from the control data abstracting unit **56**a or the scheduling information outputted from the upper layer. The data controlling unit **51**a performs a mapping of the user data and the control data which are transmitted by the uplink to each channels. In addition, the scheduling unit **53**a instructs the signature selecting unit **59**a to perform a random access based on the instruction from the upper layer. In addition, the scheduling unit **53**a instructs the signature selecting unit **59**a to perform a random access using a signature ID which is included in the synchronization update message.

The signature selecting unit **59**a selects the signature ID number which uses a random access based on the instruction from the scheduling unit **53**a, and supplies the selected signature ID number to the preamble generating unit **58**a. If the signature ID number receives an instruction from the scheduling unit **53**a, the signature selecting unit **59**a supplies the instructed signature ID number to the preamble generating unit **58**a.

The preamble generating unit **58**a generates the preamble based on the signature ID number which is selected by the signature selecting unit **59**a, and supplies it to the DFT-S-OFDM modulating unit **52**a.

In addition, the mobile station device **102**a uses the synchronization state and the non-synchronization state, and the two states are managed by the scheduling unit **53**a. If the preamble response which includes a transmitted signature ID number is received, the state is changed from the non-synchronization state to the synchronization state. In addition, if the synchronization timing shift information of the preamble response is set, the state is changed from the non-synchronization state to the synchronization state. Then, the base station device **101**a and the mobile station device **102**a communicate with each other. If the mobile station device **102**a finishes a data transmission of the uplink (including a control data), the state is changed to the non-synchronization state after a predetermined time lapses.

In the first embodiment of the present invention, the resynchronization factor detecting unit **24**a is provided in the scheduling unit **13**a of the base station device **101**a. The resynchronization factor detecting unit **24**a determines whether the data reception fails continuously based on the reception result from the control data abstracting unit **16**a. If the resynchronization factor detecting unit **24**a determines that the data reception fails continuously, the resynchronization factor detecting unit **24**a determines that the synchronization has deviated, and sends it to the UL synchronization managing unit **25**a. The UL synchronization managing unit **25**a controls the mobile station device **102**a performs a synchronization update processing.

In other words, in the synchronization state of the uplink, the data transmission from the mobile station device **102**a fails, because of rapid change of a wireless channel. However, if a retransmission process is performed a number of times, the data transmission succeeds, because a high speed hybrid automatic repeat request is used. However, in the synchronization deviation state, the data transmission fails, even if retransmission is performed repeatedly, because the transmission timing is deviated from. Therefore, it is determined that the data transmission fails continuously from the result of the reception data. Then, if the base station device **101**a fails to perform a data reception continuously n times, it is determined that the synchronization deviation state or the nearly synchronization deviation state, and the base station device orders a (non-contention-based) random access to mobile station device. In addition, if the synchronization process is necessary, it may be determined as the synchronization deviation state or the nearly synchronization deviation state. In the base station, the UL synchronization managing unit **25**a determines whether or not the resynchronization process is necessary.

An aforementioned control method is described below with reference to FIG. **4**. As shown in FIG. **4**, the mobile station device **102**a transmits the data using the uplink to the base station device **101**a (process PRC**101**). If the base station device **101**a fails to receive the data transmitted by the mobile station device **102**a, the base station device **101**a transmits the negative acknowledgement NACK to the mobile station device **102**a using the downlink (process PRC**102**). In addition, the base station device **101**a counts the number of transmissions of the negative acknowledgement NACK.

If the mobile station device **102**a receives the negative acknowledgement, the mobile station device **102**a transmits retransmission data to the base station device **101**a using the uplink (process PRC**103**). If the base station device **101**a fails to receive the data transmitted by the mobile station device **102**a again, the base station device **101**a transmits the negative acknowledgement NACK to the mobile station device **102**a using the downlink again (process PRC**104**). Then, the mobile station device **102**a transmits the retransmission data to the base station device **101**a (process PRC**105**). If the base station device **101**a fails to receive the data transmitted by the mobile station device **102**a again, the base station device **101**a transmits the negative acknowledgement NACK to the mobile station device **102**a (process PRC**106**).

If the base station device **101**a fails to receive the data from the mobile station device **102**a n times continuously, the base station device **101**a selects a signature. Then, the base station device **101**a sends a synchronization update request message which includes the signature ID and the C-RNTI using the downlink (process PRC**107**).

If the mobile station device **102**a receives the synchronization update request message, the mobile station device **102**a stops to transmit the retransmission data, and transmits the preamble by the random access channel RACH of the uplink using the signature which is included in the synchronization update request message (process PRC**108**).

If the base station device **101**a detects the preamble of the signature selected by the base station device **101**a, the base station device **101**a calculates a synchronization timing shift, and transmits a preamble response message which includes the C-RNTI and the synchronization timing shift information to the mobile station device **102**a using the downlink (process PRC**109**).

If the mobile station device **102**a receives the preamble response, the mobile station device **102**a performs a synchronization correction based on the synchronization timing shift information (process PRC**110**). In other words, the mobile station device corrects a timing of transmitting the user data and the control data based on the synchronization correction. Then, data transmission and data reception between the base station device and the mobile station device are resumed.

In addition, the synchronization update request message may include the time-frequency location of the using random access channel RACH.

FIG. **5** is a flowchart showing aforementioned processes of the base station device **101**a. The uplink data is received (step S**101**), and it is determined whether the received data is right or wrong (step S**102**). If the data is right, the acknowledgement ACK is transmitted to the mobile station device **102**a (step S**103**).

If the data is wrong, the negative acknowledgement is transmitted (step S**104**). The number of times the negative acknowledgement NACK is continuously received is counted, and it is determined whether or not the number of times the negative acknowledgement NACK is received is over n times (step S**105**). If the number is less than n times, the data reception of the uplink is performed.

If the number of continuously receiving of the negative acknowledgement is over n times, the base station device **101**a selects a signature ID (step S**106**), and generates a synchronization update request message which includes the signature ID and the C-RNTI, and sends it to the mobile station device **102**a (step S**107**). The base station device **101**a waits the preamble from the mobile station device **102**a, and if the base station device **101**a receives the preamble (step S**108**), the synchronization timing shift is calculated (step S**109**), and the preamble response message which includes the C-RNTI and the synchronization timing shift information is transmitted to the mobile station device **102**a (step S**110**). Then, the reception of the uplink is performed (step S**101**).

Second Embodiment

Next, second embodiment of the present invention is described. FIG. **6** is a block diagram showing a configuration of a base station device **101**b of a communication system according to the second embodiment of the present invention.

As shown in FIG. **6**, the base station device **101**b of the communication system according to the second embodiment includes a data controlling unit **11**b, an OFDM modulating unit **12**b, a scheduling unit **13**b, a channel estimating unit **14**b, a DFT-S-OFDM demodulating unit **15**b, a control data abstracting unit **16**b, a preamble detecting unit **17**b, a signature managing unit **18**b and a wireless unit **19**b. The scheduling unit **13**b includes a DL scheduling unit **21**b, a UL scheduling unit **22**b, a message generating unit **23**b, a resynchronization factor detecting unit **24**b, and a UL synchronization managing unit **25**b.

The configurations of the data controlling unit **11**b, the OFDM modulating unit **12**b, the DL scheduling unit **21**b, the UL scheduling unit **22**b and the message generating unit **23**b of the scheduling unit **13**b, the channel estimating unit **14**b, the DFT-S-OFDM demodulating unit **15**b, the control data abstracting unit **16**b, the preamble detecting unit **17**b, the signature managing unit **18**b, and the wireless unit **19**b are the same as the first embodiment. The explanations thereof may be omitted.

The channel estimating unit **14**b estimates wireless channel characteristics based on the reference signal for demodulating of the uplink pilot channel UPiCH, and supplies a wireless channel estimation result to the DFT-S-OFDM demodulating unit **15**b. The wireless channel estimation result is supplied to the scheduling unit **13**b for performing a scheduling of the uplink based on the reference signal which is used for measuring of the uplink pilot channel UPiCH. In addition, the uplink pilot channel UPiCH which is not able to estimate a wireless channel is reported to the scheduling unit **13**b.

The scheduling unit **13**b includes a DL scheduling unit **21**b which performs a scheduling of the downlink, a UL scheduling unit **22**b which performs a scheduling of the uplink, a message generating unit **23**b, a resynchronization factor detecting unit **24**b, and a UL synchronization managing unit **25**b.

The DL scheduling unit **21**b performs a scheduling for mapping the user data and the control data to each channel of the downlink based on the CQI information sent by the mobile station device, the data information of each users sent by the upper layer, and the control data generated by the message generating unit

The UL scheduling unit **22**b performs a scheduling for mapping the user data to each channel of the uplink based on the wireless channel estimation result of the uplink from the channel estimating unit **14**b and on the resource assignment request from the mobile station device.

The message generating unit **23**b generates the control data (for example, an ACK/NACK of the uplink data, a preamble response message, or a synchronization update request message).

If the resynchronization factor detecting unit **24**b is not able to continuously detect the reference signal of the uplink pilot channel UPiCH based on the detection result from the channel estimating unit **14**b, the resynchronization factor detecting unit **24**b determines that the synchronization of the mobile station device is deviated from, and sends to the UL synchronization managing unit **25**b that the synchronization is deviated from.

The resynchronization factor detecting unit **25**b determines whether or not a predetermined condition is fulfilled based on the signal received by the wireless unit **19**b. Specifically, the resynchronization factor detecting unit **25**b uses the predetermined condition as whether or not the reference signal is detected from the signal transmitted by the mobile station.

In addition, the resynchronize factor detecting unit **25**b counts the number of predetermined conditions not fulfilled based on aforementioned determined result. Specifically, the resynchronization factor detecting unit **25**b counts the number of not detecting the reference signal from the signal transmitted by the mobile station device.

The UL synchronization managing unit **25**b manages the uplink synchronization state of the mobile station device **102**b. In addition, the UL synchronization managing unit instructs the signature managing unit **18**b to assign a signature for performing a synchronization update process in the mobile station device **102**b.

In addition, the configuration of the mobile station device is the same as the mobile station device according to the first embodiment. Therefore, the explanation thereof is omitted.

In the communication system according to the second embodiment, the scheduling unit **13**b of the base station device **101**b includes the resynchronization factor detecting unit **24**b. The resynchronization factor detecting unit **24**b determines whether or not the reference signal is detected continuously based on the detection result of the channel estimating unit **14**b. If the reference signal is not detected, the resynchronization factor detecting unit **24**b determines that the synchronization has been deviated from, and controls the mobile station device to perform the synchronization update process.

In other words, the mobile station device which does not performs a data transmission of the uplink but may perform a data transmission regularly transmits the reference signal which is used for measuring of the uplink pilot channel UPiCH for preparing the synchronization maintenance and the data scheduling. If the uplink synchronization is established, the reference signal which is used for measuring from the mobile station device is transmitted using a transmission electric power capable of being detected by the base station device **101**b. Therefore, most of the reference signals are detected. However, in the synchronization deviation, if the reference signal which is used for measuring is repeatedly transmitted, the reference signal which is used for measuring is not detected, because the transmission timing is deviated from.

Therefore, if the base station device **101**b does not detect the reference signal which is used for measuring n times continuously, the synchronization deviation state or the nearly synchronization deviation state is determined, and the base station device orders a (Non-contention-based) random access to the mobile station device. In addition, if a synchronization process is necessary, the synchronization deviation state or the nearly synchronization deviation state may be determined. In the base station device, the UL synchronization managing unit **25**b determines whether or not the resynchronization process is necessary.

The aforementioned control method is described below in detail with reference to FIG. **7**. As shown in FIG. **7**, the mobile station device transmits the reference signal which is used for measuring regularly using the uplink (processes PRC**201** to PRC**203**). If the detection of the reference signal which is used for measuring transmitted by the mobile station device fails, the base station device counts the number of detection failures. In FIG. **7**, in processes PRC**201**, PRC**202** and PRC**203**, the reception of the reference signal which is used for measuring is failed, and a detection error occurs.

If the base station device **101**b fails to detect the reference signal which is used for measuring from the mobile station device n times continuously, the base station device **101**b selects a signature ID, and sends the synchronization update request message which includes the signature ID and the C-RNTI to the mobile station device using the downlink (process PRC**204**).

If the mobile station device receives the synchronization update request message, the mobile station device stops to transmit the reference signal which is used for measuring, and transmits the preamble for the uplink random access channel RACH using the signature which is included in the synchronization update request message (process PRC**205**). If the base station device **101**b detects the preamble of the signature selected by the base station device **101**b, the base station device calculates a synchronization timing shift, and transmits a preamble response message which includes the C-RNTI and the synchronization timing shift information to the mobile station device (process PRC**206**). If the mobile station device receives the preamble response, the mobile station device performs a synchronization correction based on the synchronization timing shift information (process PRC**207**). Then, the transmission of the reference signal which is used for measuring is resumed.

In addition, the synchronization update request message may include a time-frequency location information of using random access channel RACH.

FIG. **8** is a flowchart showing the aforementioned processes of the base station device **101**b. The uplink data is received, and the detection process of the reference signal which is used for measuring is performed (step S**201**). Then, it is determines whether or not the reference signal which is used for measuring is detected (step S**202**). If the reference signal which is used for measuring is detected, the uplink CQI is measured (step S**203**), and the synchronization timing shift is calculated (step S**204**).

If the reference signal which is used for measuring is not detected, the transmission number of continuously failing detection is counted, and determines whether or not the transmission number is over n times (step S**205**). If the transmission number is less than n times, the detection of the reference signal which is used for measuring is performed.

If the transmission number of continuously failing is over n times, a signature ID is selected (step S**206**), the synchronization update request message which includes the signature ID and the C-RNTI is generated and is transmitted to the mobile station device (step S**207**). Then, the mobile station device waits for the preamble transmitted by the mobile station device. If the mobile station device receives the preamble (step S**208**), the mobile station device detects the synchronization timing shift information from the preamble, and calculates the synchronization timing shift (step S**209**), and transits the preamble message which includes the C-RNTI and the synchronization timing shift information to the mobile station device (step S**210**). Next, the reception of the reference signal which is used for measuring is performed (step S**201**).

Third Embodiment

Next, a third embodiment of the present invention is described. FIG. **9** is a diagram showing a configuration of a base station device **101**c of a communication system according to the third embodiment of the present invention.

As shown in FIG. **9**, the base station device **101**c of the communication system according to the third embodiment includes a data controlling unit **11**c, an OFDM modulating unit **12**c, a scheduling unit **13**c, a channel estimating unit **14**c, a DFT-S-OFDM demodulating unit **15**c, a control data abstracting unit **16**c, a preamble detecting unit **17**c, a signature managing unit **18**c and a wireless unit **19**c. The scheduling unit **13**c includes a DL scheduling unit **21**c, a UL scheduling unit **22**c, a message generating unit **23**c, resynchronization factor detecting unit **24**c, and a UL synchronization managing unit **25**c.

The configurations of the data controlling unit **11**c, the OFDM modulating unit **12**c, the DL scheduling unit **21**c, the UL scheduling unit **22**c and the message generating unit **23**c of the scheduling unit **13**c, the channel estimating unit **14**c, the DFT-S-OFDM demodulating unit **15**c, the control data abstracting unit **16**c, the preamble detecting unit **17**c, the signature managing unit **18**c, and wireless unit **19**c are the same as in the first embodiment. Therefore, the explanations thereof are omitted.

The control data abstracting unit **16**c checks whether the reception data is right or wrong, and sends the check result to the scheduling unit **13**c. If the reception data is right, the reception data is separated into the user data and the control data. The control data of the layer **2** (for example, a downlink CQI information, an ACK/NACK of the downlink data) are supplied to the scheduling unit, and other data of the layer **3** (for example, a control data and a user data) are supplied to the upper layer. If the reception data is wrong, the reception data is stored to synthesize the retransmission data, and a synthesizing process is performed when the retransmission data is received. If the downlink CQI is not detected, the detection result is reported to the scheduling unit.

The scheduling unit **13**c includes a DL scheduling unit **21**c which performs downlink scheduling, a UL scheduling unit **22**c which performs uplink scheduling, a message generating unit **23**c, a resynchronization factor detecting unit **24**c, and a UL synchronization managing unit **25**c.

The DL scheduling unit **21**c performs a scheduling of the user data and the control data to each downlink channels based on the CQI information sent by the mobile station device, the data information of each users sent by the upper layer and the control data generated by the message generating unit **23**c.

The UL scheduling unit **22**c performs a scheduling for mapping the user data to each uplink channel based on the uplink wireless channel estimation result from the channel estimating unit **14**c and the resource assignment request from the mobile station device. The message generating unit **23**c generates control data (for example, an ACK/NACK of the uplink data, a preamble response message, or a synchronization update request message).

If the resynchronization factor detecting unit **24**c continuously fails to detect the downlink CQI from the control data abstracting unit **16**c based on the detection result, the resynchronization factor detecting unit **24**c determines that the synchronization has deviated, and sends the determination result to the UL synchronization managing unit **25**c.

The resynchronization factor detecting unit **24**c determines whether or not a predetermined condition is fulfilled based on the signal received by the wireless unit **19**c. Specifically, the resynchronization factor detecting unit **24**c uses whether or not the control signal is detected from the signal transmitted by the mobile station device as the predetermined condition.

In addition, the resynchronization factor detecting unit **24**c counts the number of times that the predetermined condition was not fulfilled based on the aforementioned determination result. Specifically, the resynchronization factor detecting unit **24**c counts the number that the control signal is not detected from the signal transmitted by the mobile station device. The UL synchronization managing unit **25**c manages the uplink synchronization state of the mobile station device **102**c. In addition, the UL synchronization managing unit **25**c instructs the signature managing unit **18**c to assign a signature so that the mobile station device **102**c performs a synchronization update processing.

In addition, the constitution of the mobile station device is the same as in the first embodiment. Therefore the explanation thereof is omitted.

In the third embodiment of the present invention, the scheduling unit **13**c of the base station device **101**c includes the resynchronization factor detecting unit **24**c. The resynchronization factor detecting unit **24**c determines whether a downlink CQI is continuously detected based on the detection result of the downlink CQI from the control data abstracting unit **16**c. If the downlink CQI is not continuously detected, the mobile station device performs a synchronization update process.

In other words, if the mobile station device does not receive the uplink data but receives the downlink data, the mobile station device transmits the downlink CQI for the downlink data scheduling using the uplink control channel PUCCH. In addition, the mobile station device transmits the ACK/NACK of the downlink reception data. If the uplink synchronization is established, the downlink CQI and the ACK/NACK are almost able to be detected. However, in the synchronization deviation state, the downlink CQI and the ACK/NACK are not able to be detected even if the retransmission is performed repeatedly because the transmission timing is deviated.

Therefore, if the base station device **101**c does not detect the determination of the synchronization deviation n times continuously, the base station device **101**c determines that the state is the synchronization deviation state or the nearly synchronization deviation state, and the base station device orders performs (Non-contention-based) random access to the mobile station device. In addition, the synchronization is necessary, and the synchronization deviation state or the nearly synchronization deviation state may be determined. In the base station device, the UL synchronization managing unit **25**c determines whether or not the resynchronization processing is necessary.

The aforementioned control method is described below with reference to FIG. **10**. As shown in FIG. **10**, the mobile station device regularly transmits the downlink CQI to the base station device **101**c (processes PRC**301** to PRC**303**). If the base station device **101**c fails to detect the downlink CQI transmitted by the mobile station device, the base station device counts the number of detection failure. In FIG. **10**, in the processes PRC**301**, PRC**302** and PRC **303**, reception of the CQI fails, and detection errors occurs.

If the base station device **101**c fails to detect the downlink CQI from the mobile station device n times continuously, the base station device **101**c selects a signature and sends the synchronization update request message which includes the signature ID number and the C-RNTI to the mobile station device (process PRC**304**).

If the mobile station device receives the synchronization update request message, the mobile station device stops to transmit the downlink CQI, and the preamble for the random access channel RACH using the signature which is included in the synchronization update request message (process PRC **305**). If the base station device **101**c detects the preamble of signature selected by the base station device **101**c, the base station device calculates the synchronization timing shift, and transmits the preamble response message which includes the C-RNTI and the synchronization timing shift information to the mobile station device (process PRC**306**). If the mobile station device receives the preamble response, the mobile station device performs the synchronization correction based on the synchronization timing shift information (process PRC**307**). Then, the transmission of the downlink CQI is resumed.

In addition, the synchronization update request message may include the time-frequency location of the using random access channel RACH.

FIG. **11** is a flowchart showing the aforementioned processes of the base station device **101**c. The base station device **101**c receives a signal, and performs a detection process of the downlink CQI (step S**301**). Then, the base station device **101**c determines whether or not the downlink CQI is detected (step S**302**). If the base station device **101**c detects the CQI, the base station device performs a downlink scheduling (step S**303**).

If the base station device **101**c does not detect the CQI, the base station device **101**c counts the number of continuous transmission detection failures (step S**304**). If the number of continuous transmission detection failures is less than n, the detection of the downlink is performed again (step S**301**).

If the number of continuous transmission detection failures is equal or over n, the base station device **101**c selects a signature ID (step S**305**), and generates the synchronization update request message which includes the signature ID and the C-RNTI, and sends it to the mobile station device (step S**306**). The base station device **101**c waits the preamble from the mobile station device. If the base station device **101**c receives the preamble (step S**307**), the base station device **101**c calculates the synchronization timing shift information from the preamble, and calculates the synchronization timing shift (step S**308**). The base station device **101**c transmits preamble response message which includes the synchronization timing shift and the C-RNTI to mobile station device (step S**309**). Next, the reception of the downlink is performed (step S**301**).

As described in the first to third embodiments, in spite of the synchronization maintenance state of the mobile station device, the base station device detects a synchronization deviation of the mobile station device, and the base station device transmits the synchronization recovery request signal. Therefore, in the mobile station device which is in the synchronization maintenance state, if the state changes to the synchronization deviation, it is possible to recover synchronization rapidly.

In addition, the mobile station device detects the synchronization deviation by the base station device and transmits the synchronization recovery request signal, and the synchronization state of the mobile station device changes to the non-synchronization state. By changing to the non-synchronization state, the synchronization timer is stopped (or reset), and it is possible to prohibit data transmission (include a control data) to the channel which except for the random access channel during the synchronization deviation state.

In addition, the base station device selects the signature, and the mobile station device performs a non-contention random access. Therefore, the synchronization recovery processing is finished early, and a synchronization is rapidly recovered.

Fourth Embodiment

Next, a fourth embodiment of the present invention is described. FIG. **12** is a diagram showing a configuration of a base station device **101**d of a communication system according to a fourth embodiment of the present invention.

As shown in FIG. **12**, the base station device **101**d of the communication device **101**d according to the fourth embodiment includes a data controlling unit **11**d, an OFDM modulating unit **12**d, a scheduling unit **13**d, a channel estimating unit **14**d, a DFT-S-OFDM demodulating unit **15**d, a control data abstracting unit **16**d, a preamble detecting unit **17**d, a signature managing unit **18**d and a wireless unit **19**d. The scheduling unit **13**d includes a DL scheduling unit **21**d, a UL scheduling unit **22**d and a message generating unit **23**d. These configurations are same as in the first embodiment. Therefore, explanations are omitted as much as possible.

In the base station device **101**d, there is the synchronization state and the non-synchronization state, and the scheduling unit **13**d manages the synchronization state and the non-synchronization state. If the base station device transmits the preamble response, the state is changed from the non-synchronization state to the synchronization state. Then, the base station device **101**d and the mobile station device **102**d communicate with each other. Before the synchronization timer is lapsed, the base station device **101**d transmits the synchronization information to the mobile station device **102**d, and the synchronization is maintained. If the base station device **101**d becomes not to receive the uplink data (include a control data) from the mobile station device **102**d, the state is changed to the non-synchronization state after the predetermined amount of time lapsed.

FIG. **13** is a diagram showing a configuration of a mobile station device **102**d of the communication system according to the fourth embodiment of the present invention. As shown in FIG. **13**, the mobile station device **102**d of the communication system according to a fourth embodiment includes a data control unit **51**d, a DFT-S-OFDM modulating unit **52**d, a scheduling unit **53**d, an OFDM demodulating unit **54**d, a channel estimating unit **55**d, a control data abstracting unit **56**d, a synchronization correcting unit **57**d, a preamble generating unit **58**d, a signature selecting unit **59**d, and a wireless unit **60**d (also called a signal receiving unit and a transmitting unit). The scheduling unit **53**d includes a UL scheduling unit **61**d, a resynchronization factor detecting unit **62**d, and a UL synchronization managing unit **63**d (also called an uplink synchronization managing unit).

The user data and the control data are inputted to the data control unit **51**d. The downlink CQI and the ACK/NACK are assigned to the uplink control channel PUCCH, and the user data and other signals which is except for the downlink CQI and the ACK/NACK are assigned to the uplink common channel PUSCH. In addition, the reference signal which is used for measuring and the reference signal for demodulating are assigned to the uplink pilot channel UPiCH.

The DFT-S-OFDM modulating unit **52**d performs a DFT-S-OFDM signal processing (for example, a data modulation, a DFT conversion, a sub-carrier mapping, IFFT conversion, CP (Cyclic Prefix) insertion and filtering), and a DFT-Spread-OFDM signal is generated. Here, the communication system of the uplink uses a single carrier system (for example, the DFT-spread OFDM). However, the communication system of the uplink may use a multi carrier system (for example, the OFDM system).

The synchronization correcting unit **57**d corrects a transmission timing based on the synchronization information outputted from the control data abstracting unit **56**d, and demodulated data which is suitable for the transmission timing is supplied to the wireless unit **60**d. The wireless unit **60**d sets the wireless frequency instructed by the wireless controlling unit, and up-converts the modulated data to wireless frequency, and transmits the signal to the base station device **101**d via antenna (not shown). If the number counted by the resynchronization factor detecting unit **62**d is over the predetermined number, the wireless unit **60**d transmits the synchronization signal to the base station device **101**d.

In addition, the wireless unit **60**d receives the signal transmitted by the base station device. Specifically, the wireless unit **60**d receives the downlink data transmitted by the base station device **101**d, down-converts the signal to base band signal, and supplies the reception signal to the OFDM demodulating unit **54**d.

The channel estimating unit **55**d estimates the wireless channel characteristics from the downlink pilot channel DPiCH, and supplies the estimation result to the OFDM demodulating unit **54**d. In addition, The channel estimating unit **55**d converts the signal to the CQI information to send the wireless channel estimation result to the base station device **101**d, and supplies the CQI information to the scheduling unit **53**d.

The OFDM demodulating unit **54**d demodulates the reception data from the wireless channel estimation result of the channel estimating unit **55**d.

The control data abstracting unit **56**d separates the reception data into the user data and the control data. Among the control data, the synchronization information of the uplink is supplied to the synchronization correcting unit **57**d, the scheduling information and other layer **2** control data are supplied to the scheduling unit **53**d, and the layer **3** control data and the user data are supplied to the upper layer. If the negative acknowledgement is received, it is sent to the scheduling unit **53**d.

The scheduling unit **53**d includes a UL scheduling unit **61**d which performs an uplink scheduling, a resynchronization factor detecting unit **62**d and a UL synchronization managing unit **63**d.

The uplink scheduling unit **61**d performs a mapping of user data and the control data which are transmitted by the uplink into each channels based on the control information outputted from the control data abstracting unit **56**d and the scheduling information outputted from the upper layer. In addition, the uplink scheduling unit **61**d instructs the signature selecting unit **59**d to perform a random access based on the instruction information from the upper layer.

The resynchronization factor detecting unit **62**d counts the detection result of the negative acknowledge NACK of the control data abstracting unit **56**d. If the negative acknowledge NACK is continuously received n times, the resynchronization factor detecting unit **62**d determines that the synchronization of the mobile station device **102**d is deviated, and sends it to the UL synchronization managing unit **63**d.

In other words, the resynchronization factor detecting unit **62**d determines whether or not the signal received by the wireless unit **60**d is the retransmission request. Specifically, the resynchronization factor detecting unit **62**d uses whether or not the signal transmitted by the base station device **101**d is the signal which indicates receiving is impossible.

In addition, the resynchronization factor detecting unit **62**d counts the number of times the signal received by the wireless unit **60**d is determined as the retransmission request. Specifically, the resynchronization factor detecting unit **62**d counts the number of the signal transmitted by the base station device **101**d which indicates that the receiving is impossible. The UL synchronization managing unit **63**d manages the uplink synchronization state of the mobile station device **102**d. In addition, to perform the synchronization update processing by the mobile station device, the UL synchronization managing unit **63**d instructs the signature selecting unit **59**d to perform a random access to the signature managing unit **18**d.

FIG. **14** is a state diagram of a UL synchronization managing unit **63**d according to the fourth embodiment of the present invention. The mobile station device **102**d performs a random access to the base station device **101**d. If the mobile station device **102**d receives the random access response from the base station device **101**d (step B**01**), a state is changed to the synchronization state.

If the communication between the base station device **101**d and the mobile station device **102**d is finished and the predetermined amount of time has lapsed (the synchronization timer is expired) (step B**02**), and the state is changed to the synchronization non-maintenance state. In the synchronization maintenance state, there is the synchronization state and the non-synchronization state. When it is changed from the step B**01**, the synchronization state of the synchronization maintenance state is set.

During the synchronization state of the synchronization maintenance state, the synchronization timing shift information is received from the base station device **101**d before the synchronization timer elapsed, and the synchronization state is maintained. If the resynchronization factor detecting unit **62**d determines that the state is the synchronization deviation from the detection result of the negative acknowledge NACK of the control data abstracting unit **56**d (step B**03**), the state is changed to the non-synchronization state of the synchronization maintenance state.

If the state is changed to the non-synchronization state of the synchronization maintenance state, the instruction of performing the random access is supplied to the signature selecting unit **59**d to perform the synchronization update processing. The mobile station device **102**d selects the signature ID, and performs a random access using the preamble of the selected signature ID. Then, the base station device **101**d detects the preamble, and transmits the preamble response to the mobile station device **102**d. If the mobile station device **102**d receives the preamble response and updates the synchronization from the synchronization timing shift information, the state is changed to the synchronization state of the synchronization maintenance state.

In addition, the synchronization maintenance state is the state that the base station device and the mobile station device are communicated with each other and the mobile station device receives the downlink data (include a control data) and transmits the uplink data (include a control data), or is a state before the synchronization timer expires.

The signature selecting unit **59**d selects the signature ID number which uses the random access based on the instruction from the scheduling unit **53**d, and supplies the selected signature ID number to the preamble generating unit **58**d. If the signature ID number is supplied from the scheduling unit **53**d, the instructed signature ID number is supplied to the preamble generating unit **58**d.

The preamble generating unit **58**d generates the preamble based on the signature ID number selected by the signature selecting unit **59**d, and supplies it to the DFT-S-OFDM modulating unit **52**d.

In the first to third embodiments, the base station device **101**d detects the synchronization deviation. However, in the fourth embodiment, the mobile station device detects the synchronization deviation.

If the uplink synchronization is established, the data transmission from the mobile station device **102** fails because of rapidly changing wireless channels. However, if the retransmission process is repeated a few times, the data transmission succeed, because a high speed hybrid automatic repeat request is used. However, in the state of the synchronization deviation, if the retransmission is repeated, the data transmission does not succeed because the transmission timing is deviated from.

Therefore, data transmitted by the mobile station device for the response of the synchronization deviation determination from the base station device **101**d is received n times continuously, it is determined that the state is the uplink synchronization deviation state or the nearly synchronization deviation state, and the mobile station device performs a (contention-based) random access. In addition, if the synchronization process is necessary, the synchronization deviation state or the nearly synchronization deviation state may be determined. The mobile station device determines whether or not the resynchronization process is necessary by the UL synchronization managing unit **62**d.

The aforementioned control method is described below with reference to FIG. **15**. As shown in FIG. **15**, the mobile station device **102**d transmits the data to the base station device **101**d using the uplink (process PRC**401**). If the reception of the data transmitted by the mobile station device **102** fails, the base station device **101**d transmits the negative acknowledgement NACK to the mobile station device **102**d using the downlink (process PRC**402**).

If the mobile station device **102**d receives the negative acknowledge NACK, the mobile station device **102**d transmits the retransmission data to the base station device **101**d (process PRC**403**). Then if the reception of data transmitted by the mobile station device **102**d fails again, the base station device **101**d transmits the transmitted data to the mobile station device **102**d again (process PRC**404**). Then, the mobile station device **102**d transmits the retransmission data to the base station device **101**d (process PRC**405**). If the reception of data transmitted by the mobile station device **102**d fails again, the mobile station device **102**d transmits the negative acknowledge NACK to the mobile station device **102**d again (process PRC**406**).

If the mobile station device **102**d receives the negative acknowledgement NACK, the mobile station device **102**d counts the negative acknowledgement NACK. If the mobile station device **102**d receives the negative acknowledge NACK of the data transmitted by the mobile station device **102**d n times continuously, the mobile station device stops the transmission of the retransmission data. Then the mobile station device **102**d selects the signature, and transmits the preamble to the random access channel RACH of the uplink (process PRC**407**).

If the preamble is detected, the base station device **101**d calculates the synchronization timing shift, and performs a scheduling for transmitting the L2/L3 message by the mobile station device **102**d. Then, the base station device **101** transmits the preamble response message which includes the RA-RNTI, the synchronization timing shift information, and the scheduling information of the L2/L3 message (process PRC**408**).

If the mobile station device **102**d receives the preamble response, the mobile station device **102**d performs a synchronization correction based on the synchronization timing shift information, and transmits the L2/L3 message which represents the synchronization is updated (process PRC**409**).

If the L2/L3 message is received, the base station device **101**d transmits the contention resolution to the mobile station device **102**d (process PRC**410**). If the mobile station device **102**d receives the contention resolution, the data transmission and the data reception between the base station device and the mobile station device are resumed.

FIG. **16** is a flowchart showing the aforementioned processes of the mobile station device **102**d. The response of the transmission data of the uplink is received (step S**401**). It is determined whether or not the response from the base station device **101**d is the acknowledgement ACK or the negative acknowledgement NACK (step S**402**). If the response is the acknowledgement ACK, new data is transmitted to the base station device **101**d (step S**403**).

If the response is the negative acknowledgement NACK, the retransmission data is transmitted, and the number of continuously transmitting the negative acknowledgement is counted, and it is determined whether or not the continuously transmission number of the negative acknowledge is over n times (step S**404**). If the continuously transmission number of the negative acknowledgement NACK is less than n times, the retransmission data is transmitted (step S**405**). Then, the reception of the ACK/NACK is performed (step S**401**).

If the continuously transmission number of the negative acknowledgement NACK is over n times, a signature is selected (step S**406**), and the preamble is transmitted to the random access channel RACH (step S**407**). Then, the preamble response is waited. If the preamble response is received (step S**408**), the synchronization correction is performed using the synchronization timing shift information which is included in the preamble response (step S**409**), and the L2/L3 message which represents the synchronization being updated is generated, and the L2/L3 message is transmitted to the base station device **101**d (step S**410**). Then, the reception of the contention resolution is waited, the contention resolution is received (step S**411**), and data transmission is resumed. Then, the retransmission data is transmitted (step S**405**).

Fifth Embodiment

Next, a fifth embodiment of the present invention is described. FIG. **17** is a diagram showing a configuration of a mobile station device **102**e of the communication system according to the fifth embodiment of the present invention.

As shown in FIG. **17**, the mobile station device **102**e according to the fifth embodiment includes a data controlling unit **51**e, a DFT-S-OFDM modulating unit **52**e, a scheduling unit **53**e, an OFDM demodulating unit **54**e, a channel estimating unit **55**e, a control data abstracting unit **56**e, a synchronization correcting unit **57**e, a preamble generating unit **58**e, a signature selecting unit **59**e, and a wireless unit **60**e (also called a signal receiving unit, a transmitting unit). The scheduling unit **53**e includes an uplink scheduling unit **61**e, a resynchronization factor detecting unit **62**e, and a UL synchronization managing unit **63**e.

The use data and the control data are supplied to the data controlling unit **51**e. Based on the instructions from the scheduling unit **53**e, the downlink CQI and the ACK/NACK are assigned to the uplink control channel PUCCH, and the user data and signals except for the downlink CQI and the ACK/NACK are assigned to the uplink common channel. In addition, the reference signal which is used for measuring and the reference signal for demodulating are assigned to the uplink pilot channel UPiCH.

The DFT-S-OFDM modulating unit **52**e performs the DFT-S-OFDM signal processing (for example, a data modulation, and performs a DFT conversion, a sub-carrier mapping, an IFFT conversion, a CP (Cyclic Prefix) insertion and filtering) and a DFT-Spread-OFDM signal is generated. Here, the uplink communication system uses a single carrier system (for example, a DFT-spread OFDM). The uplink communication system may use a multi carrier system (for example, OFDM system):

The synchronization correcting unit **57**e corrects the transmission timing based on the synchronization information supplied by the control data abstracting unit **56**e, and supplies the data modulated to be suitable for the transmission timing to the wireless unit **60**e.

The wireless unit **60**e sets the signal to a wireless frequency instructed by the wireless controlling unit, and performs an up-convert of the demodulated data to wireless frequency, and transmits to the base station device **101**e via antenna (not shown). If the number counted by the resynchronization factor detecting unit **62**e is over the predetermined number, the wireless unit **60**e transmits the synchronization signal to the base station device **101**e.

In addition, the wireless unit **60**e receives the signal transmitted by the base station device **101**e. Specifically, the wireless unit **60**e receives the downlink data from the base station device **101**e, and performs a down-conversion to a base band signal, and supplies the reception signal to the OFDM demodulating unit **54**e.

The channel estimating unit **55**e estimates the wireless channel characteristics based on the downlink pilot channel DPiCH, and supplies the estimation result to the OFDM demodulating unit **54**e. In addition, the channel estimating unit **55**e converts the signal to the CQI information to send the wireless channel estimation result, and supplies the CQI information to the scheduling unit **53**e.

The OFDM demodulating unit **54**e demodulates the reception data from the wireless channel estimation result of the channel estimating unit **55**e. The control data abstracting unit **56**e separates the reception data into the user data and the control data. Among the control data, the synchronization information of the uplink is supplied to the synchronization correcting unit **57**e, the scheduling information and signals except for the control data of the layer **2** are supplied to the scheduling unit **53**e, and the control data of layer **3** and the user data are supplied to the upper layer. If the reception of the broadcast channel fails, it is reported to the scheduling unit **53**e.

The scheduling unit **53**e includes a UL scheduling unit **61**e which performs a scheduling of the uplink, a resynchronization factor detecting unit **62**e, and a UL synchronization managing unit **63**e.

The UL scheduling unit **61**e performs a mapping of the user data and control data which are transmitted in the uplink based on the control information supplied by the control data abstracting unit **56**e and the scheduling information supplied by the upper layer. In addition, the UL scheduling unit **61**e instructs the signature selecting unit **59**e to perform a random access based on information instructed by the upper layer. The resynchronization factor detecting unit **62**e counts the result of the control data abstracting unit **56**e. If the reception of the broadcast channel fails n times continuously, the resynchronization factor detecting unit **62**e determines that the synchronization of the mobile station device **102**e deviates, and sends it to the UL synchronization managing unit **63**e.

The resynchronization factor detecting unit **62**e determines whether or not the signal received by the wireless unit **60**e of the base station device **101**e is a retransmission request. Specifically, the resynchronization factor detecting unit **62**e determines whether or not the signal of broadcast channel is detected from the signal transmitted by the base station device **101**e, as the predetermined condition.

In addition, the synchronization factor detecting unit **62**e counts the number that the wireless unit **60**e determines the received signal received by the wireless unit **60**e from the base station device **101**e as the retransmission signal. Specifically, the resynchronization factor detecting unit **62**e counts the number of not being able to detect the signal of the broadcast from the signal transmitted by the base station device **101**e. The UL synchronization managing unit **63**e manages the uplink synchronization state of the mobile station device **102**e. In addition, the UL synchronization managing unit **63**e instructs the signature selecting unit **59**e to perform a random access for performing a synchronization update process by the mobile station device **102**e.

The signature managing unit **59**e selects a signature ID number which is used in the random access based on the instruction from the scheduling unit **53**e. The signature managing unit **59**e supplies the selected signature ID number to the preamble generating unit **58**e. If the signature ID number is instructed from the scheduling unit **53**e, the instructed signature ID number is supplied to the preamble generating unit **58**e.

The preamble generating unit **58**e generates the preamble based on the signature ID number selected by the signature selecting unit **59**e, and supplies it to the DFT-S-OFDM modulating unit **52**e.

In the first to fourth embodiments, the uplink synchronization deviation is detected. However, in the fifth embodiment, a downlink synchronization deviation is detected.

If the synchronization is deviated from in the downlink, the synchronization of the uplink is also deviated from, because the synchronization of the uplink refers to the downlink. Therefore, if the downlink synchronization is deviated from, the uplink synchronization deviation is determined as the uplink synchronization deviation state, and the mobile station performs a (contention-based) random access. In addition, the synchronization deviation state is equal to the state which needs a synchronization processing. In the mobile station device, the UL synchronization managing unit **62**e determines whether or not the resynchronization process is necessary. The broadcast channel BCH of the downlink common control channel CCPCH is 20 ms. In other words, the broadcast channel BCH is transmitted 20 ms interval. Therefore, the downlink synchronization deviation is the state that the reception of a broadcast channel of the downlink common control channel CCPCH continuously fails.

The aforementioned controls method is described below in detail with reference to FIG. **18**. As shown in FIG. **18**, the mobile station device **102**e transmits the uplink data (process PRC**500**), and regularly receives the broadcast channel from the base station device (processes PRC**501** to PRC**503**). In FIG. **18**, in processes PRC **501**, PRC**502** and PRC**503**, the reception of the broadcast channel fail. If the reception of the broadcast channel, the mobile station device **102**e counts the number of the failure of reception.

If the mobile station device **102**e receives the broadcast channel n times continuously, the mobile station device **102**e performs a downlink synchronization. After establishes the downlink synchronization (process PRC**504**), and selects a signature, and transmits the preamble to the random access channel RACH (process PRC**505**).

If the preamble is detected, the base station device **101**e detects the synchronization timing shift. Then, the mobile station device **102**e performs a scheduling for transmitting the L2/L3 message to the mobile station device **102**e, and transmits the preamble response message which includes the RA-RNTI and the synchronization timing shift information and the L2/L3 message of the scheduling information (process PRC**506**).

If the mobile station device **102**e receives the preamble response, the mobile station device **102**e performs a synchronization correction based on the synchronization timing shift information, and transmits the L2/L3 message which indicates the synchronization is updated (process PRC**507**). If the base station device **101**e receives the L2/L3 message, the base station device **101**e transmits the contention resolution to the mobile station device **102**e (process PRC**508**). If the mobile station device **102**e receives the contention resolution, the data transmission and the data reception between the base station device and the mobile station device are resumed.

FIG. **19** is a flowchart showing aforementioned processes of the mobile station device **102**e. The downlink broadcast channel is received (step S**501**), and a CRC checking of the broadcast channel is performed, and it is determined whether the reception is a success or failure (step S**502**). If the reception is a success, the reception process is maintained.

If the reception is failure, the number of reception failures is counted. Then, it is determined whether or not the continuous number of the reception failure is over n times (step S**503**). If a continuous number of the reception failures is less than n times, the reception process is maintained.

If the continuous number of reception failures is over n times, the synchronization process of the downlink is performed. After the downlink synchronization is established, a signature is selected (step S**504**), the preamble is transmitted to the random access channel RACH (step S**505**). Then, the reception of the preamble response is waited. If the preamble response is received (step S**506**), the synchronization correction is performed using the synchronization timing shift information which is included in the preamble response (step S**507**), the L2/L3 message which indicates the synchronization is updated is generated, the L2/L3 message is transmitted to the base station device **101**e (step S**508**). The reception of the contention resolution is waited. After the contention resolution is received, the data transmission is resumed (step S**509**). Next, the reception of the broadcast channel BCH is performed (step S**501**).

In addition, in the fifth embodiment, the downlink synchronization deviation (synchronization deviation of the uplink) is detected based on the reception condition of the downlink common control channel CCPCH. However, the downlink synchronization deviation (synchronization deviation of the uplink) may be detected based on the reception condition of the data of the mobile station transmitted in the downlink common channel PDSCH. In addition, the downlink synchronization deviation may be detected based on the reception condition of the downlink pilot channel DPiCH. In this case, the downlink synchronization deviation may be detected by continuously failing to receive the downlink pilot channel DPiCH. In addition, the downlink synchronization may be measured by the downlink pilot channel DPiCH or the downlink synchronization channel DSCH, and the downlink synchronization may be determined if the synchronization deviation quantity is over a predetermined quantity. In the fourth and fifth embodiments, in spite of the synchronization maintenance state of the mobile station device, the synchronization deviation is detected, and the synchronization signal is transmitted to base station device. Therefore, if the mobile station device in the synchronization maintenance state becomes the synchronization deviation, it is possible to recover the synchronization early. In addition, the base station device is able to detect the synchronization deviation because the mobile station device transmits the synchronization signal, and the synchronization timer for transmitting the synchronization information is stopped (or reset).

Moreover, in each of the above described embodiments, it is also possible to control the base station device and the mobile station device by recording on a computer-readable recording medium a program which realizes the functions or a portion of the functions of each section of the base station device (see FIG. **1**, FIG. **6**, FIG. **9**, FIG. **12**) and each section of the mobile station device (see FIG. **3**, FIG. **13**, FIG. **17**) of the first through fifth embodiments, and by causing this program recorded on a recording medium to be read and executed by a computer system. Note that, here, 'computer system' includes the OS and hardware such as peripheral devices and the like.

Moreover, 'computer readable recording medium' refers to a storage medium such as a portable medium such as a flexible disc, a magneto-optical disc, a ROM, a CD-ROM, or a hard disc incorporated in a computer system or the like. Furthermore, 'computer readable recording medium' also includes devices that hold a program dynamically for short periods of time such as communication lines when the program is transmitted via a network such as the Internet or via a communication circuit such as a telephone line, and includes devices which hold a program for a fixed period of time such as the volatile memory incorporated in computer systems which form the servers and clients in the case of the communication lines or networks described above. The above described program may realize a portion of the above described functions or may realize the above described functions in combination with a program which has already been recorded on a computer system.

Embodiments of this invention have been described in detail above with reference made to the drawings, however, the specific structure of this invention is not limited to these embodiments and other designs and the like are also included insofar as they do not depart from the spirit or scope of this invention.

INDUSTRIAL APPLICABILITY

The present invention provides a base station device, a mobile station device, a communication system and a communication method which makes it possible to detect a synchronization deviation early by the base station device or the mobile station device, and recovering from the synchronization state to the synchronization state early, if an uplink synchronization is deviated.

The invention claimed is:

1. A mobile station device which communicates with a base station device, the mobile station device comprising:

a [transmission/reception unit] *transmitter/receiver* configured to

transmit data to the base station device on dedicated channels assigned to the mobile station *device*,

receive a response from the base station device, and

retransmit the data on the dedicated channels in case that the response of the base station device for the data is a predetermined response; and

[a random access performing section] *the transmitter/receiver* configured not to retransmit the data on dedicated channels but to perform random access on a random access channel that is a non-dedicated channel in case that the predetermined response is detected over predetermined times.

2. The mobile station device according to claim **1**, wherein the predetermined response is a Negative Acknowledgment (NACK).

3. A communication method of a mobile station device, the communication method comprising:

transmitting data to a base station device on dedicated channels assigned to the mobile station *device*;

receiving a response from the base station device;

retransmitting the data on the dedicated channels in case that the response of the base station device for the data is predetermined response; and

performing random access on a random access channel that is a non-dedicated channel, without transmission of the data on the dedicated channels, in case that the predetermined response is detected over predetermined times.

4. A communication method of a user equipment, the communication method comprising:

detecting responses of a base station device for transmitting data to the base station device,

wherein the data is transmitted on uplink to the base station device by the user equipment and the data is retransmitted by the user equipment in a case that a predetermined condition is not satisfied; and

performing random access on a random access channel to the base station device in a case that the predetermined condition is satisfied, wherein the random access is contention based random access.

5. The communication method according to claim 4 wherein, the communication method comprises:

cancelling retransmission of the data in case that a positive response is detected; and

retransmitting the data in case that a negative response being other than the positive response is detected.

6. A user equipment which communicates with a base station device, the user equipment comprising:

a receiver/transmitter configured to and/or programmed to detect responses of the base station device for transmitting data to the base station device,

wherein the data is transmitted on uplink to the base station device by the user equipment and the data is retransmitted by the user equipment in a case that a predetermined condition is not satisfied; and

the receiver/transmitter configured to and/or programmed to perform random access on a random access channel to the base station device in a case that the predetermined condition is satisfied, wherein the random access is contention based random access.

7. The user equipment according to claim 6 wherein, the receiver/transmitter is further configured to and/or programmed to:

cancel retransmission of the data in case that a positive response of the base station is detected; and

retransmit the data in case that a negative response of the base station being other than the positive response of the base station is detected.

8. A processing device that is mounted in a user equipment, the processing device comprising:

a receiver/transmitter configured to and/or programmed to detect responses of a base station device for transmitting data to the base station device,

wherein the data is transmitted on uplink to the base station device by the user equipment and the data is retransmitted by the user equipment in a case that a predetermined condition is not satisfied; and

the receiver/transmitter configured to and/or programmed to perform random access on a random access channel to the base station device in a case that the predetermined condition is satisfied, wherein the random access is contention based random access.

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