(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
13 September 2001 (13.09.2001)

PCT

(10) International Publication Number
WO 01/67620 A2

(51) International Patent Classification[7]: H04B

(21) International Application Number: PCT/SE01/00492

(22) International Filing Date: 8 March 2001 (08.03.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/188,469 10 March 2000 (10.03.2000) US
09/652,064 31 August 2000 (31.08.2000) US

(71) Applicant: TELEFONAKTIEBOLAGET LM ERICSSON (publ) [SE/SE]; S-126 25 Stockholm (SE).

(72) Inventors: NYSTRÖM, Johan; Kronobergsgatan 22, S-112 33 Stockholm (SE). SPALING, Gerke; Mirastraat 21, NL-7521 ZE Enschede (NL).

(74) Agent: LUNDHOLM-CARLSSON, Lena; Ericsson Radio Systems AB, Patent Unit Research, S-164 80 Stockholm (SE).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 01/67620 A2

(54) Title: UPLINK SYNCHRONIZATION SIGNAL TRANSMISSION IN TDD SYSTEMS

(57) Abstract: A Time Division-Synchronous Code Division Multiple Access (TD-SCDMA) communication network implements a frame structure having a constant slot size. Signaling information, including e.g., synchronization information, for a particular connection is superimposed at a predetermined offset from the beginning of a selected slot in the frame, and the offset is transmitted on the Common Broadcast Channel (BCH). Also, the synchronization information preferably is transmitted in the same slot with the Random Access CHannel (RACH). To establish a communication link, a transmitter operating in the network selects a first code word and a first time location within an uplink time slot, superimposes the first code word on the first time location within the uplink time slot, and transmits the first code word in the chosen time location. A receiver searches for a match of the first code word in at least one time location in at least one time slot designated for the uplink, and determines a possibly empty set of likely candidates for code words and locations; and if the set of candidates is not empty, estimates the time difference between at least one of the candidates time locations and at least one of the predefined time locations.

UPLINK SYNCHRONIZATION SIGNAL TRANSMISSION IN TDD SYSTEMS

RELATED APPLICATION

This application is related to, and claims priority from, U.S. Provisional Application Serial No. 60/188,469 entitled "Uplink Synchronization Signal Transmission in TDD Systems" filed on March 10, 2000, the disclosure of which is expressly incorporated herein by reference.

BACKGROUND

The present invention relates to cellular communication networks, and more particularly to systems and methods for operating a cellular communication network that utilizes time-division access techniques.

Public cellular communication networks (public land mobile networks) are commonly employed to provide voice and/or data communication services to network subscribers. Information (e.g., voice, video, data) is encoded as a modulated radio frequency carrier wave and transmitted across an air interface, e.g., between a cellular communication network node and one or more remote terminals. Each cell in the network typically includes at least one base transceiver station (BTS), also referred to as a base station (BS), which is managed by a base station controller (BSC). The network's BSCs are connected via control nodes to a core telecommunication network. Examples of control nodes include mobile services switching center (MSC) nodes for connecting to connection-oriented, circuit switched networks such as PSTN and/or ISDN, and general packet radio service (GPRS) nodes for connecting to packet-switched networks such as the Internet.

A cellular telephone is one example of what is referred to as a "remote terminal", "mobile station", or "mobile terminal". Other examples of remote terminals include personal computers (PCs), personal digital assistants (PDAs), pagers, etc. Some remote terminals are capable of running multiple applications, such as, for example, Internet browsers and electronic mail programs. Several multimedia applications may reside in the same remote terminal.

Cellular communication networks employ various modes of operation (e.g., analog, digital, dual mode, etc.), and various access techniques such as frequency division multiple access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA), or hybrids of these techniques. In an FDMA network, communication signals are transmitted as modulated waveforms over separate frequency bands in a spectrum of carrier frequencies. The frequency bands serve as communication channels over which remote terminals communicate with the network. In the United States, for example, Federal authorities have allocated to cellular communications a block of the UHF frequency spectrum further subdivided into pairs of narrow frequency bands, a system designated EIA-553 or IS-19B.

A TDMA network may be implemented by subdividing the frequency bands employed in conventional FDMA systems into successive time slots, and a communication channel typically includes one or more time slots in one or more frequency bands. The time slots are usually organized into successive frames, each of which includes a plurality of discrete time slots. Examples of networks employing TDMA include the digital advanced mobile phone service (D-AMPS), some of the characteristics of which are specified in the TIA/EIA/IS-136 standard published by the Telecommunications Industry Association and Electronic Industries Association (TIA/EIA) European Global System for Mobile Communication (GSM) standard. In these TDMA networks, each user communicates with the base station using bursts of digital data transmitted during the user's assigned time slots.

A third channel access technique is Code Division Multiple Access (CDMA). CDMA access techniques allow user communications to overlap in both time and frequency; channels are defined by unique codes assigned to users. In a CDMA network, an electrical signal embodying an informational data stream (e.g., digitized voice, data, video) to be transmitted is combined with an electrical signal embodying a higher bit rate data stream referred to as a signature sequence, or spreading sequence, to produce a spread spectrum signal. The information required to decode the spread spectrum signal (e.g., the unique signature sequence) may be transmitted to an intended receiver over a separate communication channel (e.g., a pilot channel or a control channel). Using this information, the intended receiver can extract the informational data stream from the spread spectrum signal, thereby establishing a communication channel with the transmitter.

Time division duplex (TDD) access techniques for digital radio communication networks divide time into slots which may be used for either uplink (UL) or downlink (DL) transmission. In each time slot, one or many data packets can be transmitted in either direction depending on the access technique used. The TDMA access technique in its basic form separates packets by transmitting them in different time slots. By contrast, CDMA access systems allow more than one packet to be transmitted in each time slot. The invention described herein is equally applicable to TDMA networks, CDMA networks, and hybrids thereof. In TDMA-CDMA hybrid systems many packets could share each time slot by means of code division techniques. Hence, both codes and/or choice of time slot could separate packets.

Access techniques may be characterized as either synchronous or asynchronous. In networks employing synchronous access techniques, data packets are transmitted in a predetermined time slot(s) within a frame structure. Synchronous access techniques are easily implemented in the downlink since most base stations include sufficient processing power to align the packets before transmission. Synchronous access techniques also may simplify the receiver algorithms in the mobile terminal. In a synchronous network, the receiver in the mobile terminal can assume that the received packets occupy a predetermined position within the frame. This is particularly beneficial in CDMA networks, in which information signals typically are spread with orthogonal codes which, under proper transmission conditions, means that at the mobile terminal the information signals are also received in an orthogonal fashion.

Synchronous systems are slightly more complex to implement in mobile terminals. Because mobile terminals may move with respect to the base station, data transmitted from a mobile terminal to the base station may experience a variable propagation delay. To compensate for the variation in the propagation delay, a mobile terminal must adapt its transmission timing to the propagation delay. Therefore, to implement a synchronous access technique, a mobile terminal must also implement a suitable control mechanism to compensate for variations in the propagation delay.

SUMMARY

In one aspect, the present invention provides a method for transmitting uplink synchronization information from at least one transmitter in a cellular digital radio communication system using a time division duplex multiple access technique. A method according to the invention comprises the steps of: selecting, at the transmitter, a first code word; selecting, at the transmitter, a first time location within an uplink time slot; superimposing the first code word on the first time location within the uplink time slot, wherein the uplink time slot contains resources for at least one physical control channel and at least one pilot signal; and transmitting, from the transmitter, the first code word in the set of chosen time locations.

In another aspect, the invention provides a method of receiving uplink synchronization information from at least one transmitter in a cellular digital radio communication network using time division duplex multiple access, wherein the synchronization information is represented by a first code word superimposed on an uplink time slot transmitted in a predetermined time location within a frame structure. The method comprises the steps of: searching for a match of the first code word in at least one time location in at least one time slot designated for the uplink; and determining a possibly empty set of likely candidates for code words and locations; and if the set of candidates is not empty, estimating the time difference between at least one of the candidate's time locations and at least one of the predefined time locations.

BRIEF DESCRIPTION OF DRAWINGS

These and other objects, features and advantages of the present invention will become more readily apparent to those skilled in the art upon reading the following detailed description of exemplary embodiments, in conjunction with the appended drawings, in which:

Fig. 1 is a schematic illustration of a frame structure and a slot structure for a TD-SCDMA communication system;

Fig. 2 is a schematic illustration of a modified frame structure for a TD-SCDMA communication system in accordance with aspects of the present invention;

Fig. 3 is a schematic illustration of a modified slot structure for a TD-SCDMA communication system in accordance with aspects of the present invention;

Fig. 4 is a flowchart illustrating a method of transmitting communication signals in accordance with aspects of the present invention;

Fig. 5 is a flowchart illustrating a method of receiving communication signals in accordance with aspects of the present invention.

DETAILED DESCRIPTION

In the following description, for purposes of explanation and not limitation, specific details are set forth, such as particular frame protocols, frame structures, techniques, etc. in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details. In other instances, detailed descriptions of well-known methods, devices, and frame structures are omitted so as not to obscure the description of the present invention.

Fig. 1 is a schematic illustration of an existing frame structure and a slot structure for a Time-Division - Synchronous Code Division Multiple Access (TD-SCDMA) communication system. By way of example, and not by limitation, the present invention may be implemented in a network operated pursuant to Universal Mobile Telephone System (UMTS) standards. The frame structure consists of two subframes 110, each of which is of a 5 millisecond (ms) duration. Each subframe 110 is divided into eight slots, seven traffic slots used to transmit data and one signaling slot. Each traffic slot represents 0.675 ms, which corresponds to 864 chips at a chip rate of 1.28 Mchips. Each traffic slot includes two data sections 124 which correspond to 352 chips (304 data and 48 control), a midamble 126 which corresponds to 144 chips, and a gap period 126 of 16 chips. The seven traffic slots may be allocated as desired between one downlink segment and one uplink segment. In the embodiment illustrated in Fig. 1, the downlink segment includes n time slots and the uplink segment includes m time slots, where m+n=7.

The downlink segment and the uplink segment are separated by a signaling slot. The signaling slot consists of a downlink part 128 (DwPTS), a guard period 130 (GP), and an uplink part 132 (UpPTS). The downlink part includes a signal called SYNC that helps the mobile terminal synchronize to the network. The uplink part includes a signal called SYNC1 that helps the base station estimate the timing and power of the mobile terminal as a basis for uplink synchronization.

The existing TD-SCDMA frame structure prescribes particular locations within the frame structure for the B-CHannel (BCH) data, and for the Random Access CHannel (RACH). The BCH, which describes the configuration of the frame, is always located in the first download slot (DL#1). The RACH, which carries a Random Access Channel Request from the mobile terminal when the mobile terminal requests access to the network, is always positioned in the timeslot immediately following the UpPTS.

In operation, a mobile terminal in a TD-SCDMA communication system uses information in the DwPTS segment 128 and the UpPTS segment 132 to synchronize with the network and to access the network. In brief, to perform an initial synchonization, a mobile terminal operating in a TD-SCDMA cell searches the signal received from the base station for the occurrence of a valid SYNC signal. Typically, the search is implemented using a bank of matched filters tuned to receive candidate SYNC signals. When the mobile terminal detects a valid SYNC signal, the mobile terminal can immediately determine the position within the frame structure of the first download slot (DL#1), which includes the common broadcast channel (BCH) data defining the frame configuration. The mobile terminal can also use the frame configuration to estimate the approximate location of the UpPTS segment and the first upload slot, which is used to transmit a Random Access Channel Request to the network. The mobile terminal can also use information on the BCH to approximate the desired power for transmission.

When the mobile terminal wants to establish a communication session with the network, it performs an initial upload synchronization and random access request procedure as follows: First, the mobile terminal performs a download synchronization substantially as described above. Then the mobile terminal selects a random code SYNC1 to transmit to the base station in the time slot corresponding to the UpPTS segment 132 estimated by the mobile terminal. The SYNC1 code is transmitted at a desired power level estimated by the mobile terminal.

The base station receives the frame structure from the mobile terminal and scans the UpPTS segment and adjacent time slots for the occurrence of a valid SYNC1 signal. The base station estimates the mobile terminal's timing error based on the difference between the position within the frame structure of the detected SYNC1 signal and the expected position of the SYNC1 signal, relative to the position of the UpPTS segment 132. The base station then estimates the difference between the expected power of the received SYNC1 signal and the actual power of the received SYNC1 signal. The base station then signals timing and power corrections to the mobile terminal on the FACH channel. The mobile terminal reads the timing and power correction information in the FACH channel, adjusts its timing and power accordingly, and prepares and transmits a random access burst in uplink slot #1.

The synchronization of the uplink may be maintained by periodic information updates between the base station and the mobile terminal. For each mobile terminal in range, a base station can use the timing and power estimates to keep the main channel taps together for all mobile terminals.

The existing TD-SCDMA frame structure provides a one-to-one mapping of the UpPTS segment 132 to the random access time slot. Also, the size and position of control slots are fixed, and are different than the size of data slots. While these characteristics are adequate for coordinated systems (e.g., networks in which the timing of the DwPTS segments are coordinated), these characteristics create several technical issues when interference occurs in networks that are not coordinated. In particular, it is not possible to shift the signaling channels to a different slot in the frame if the signaling channels are affected by interference.

Also, in uncoordinated operation of two TD-SCDMA networks (e.g., when the networks are not aligned along the DwPTS segments 128), interference from a downlink in a first network might interfere with the UpPTS segment 136 or RACH in a second network's uplink. This interference may cause the second system to jam since the uplink signal is necessary for the initial setup of a connection.

Fig. 2 is a schematic depiction of an alternative TD-SCDMA frame structure in accordance with aspects of the invention. The frame structure depicted in Fig. 2 has sixteen (16) slots of equal size in a 10 ms time span. The allocation of slots between the uplink and the downlink (e.g., the uplink/downlink configuration) of the frame structure can be determined separately for each slot to allow for efficient reallocation of traffic and control channels in both directions. In the embodiment depicted in Fig. 2, the frame structure is divided into two sub-frames, each of which has five (5) slots dedicated to the downlink and three (3) slots dedicated to the uplink. In accordance with the invention, downlink signaling information (e.g., DwPTS) may be superimposed on any downlink slot in the frame structure, and uplink signaling information (e.g., UpPTS) may be superimposed on any uplink slot in the frame structure. In one exemplary embodiment, the SYNC1 signal is superimposed on an uplink RACH slot that contains unused resources. Superimposing the SYNC1 signal on a RACH slot creates a direct mapping between the location of the SYNC1 signal and the RACH time slot. Thus, the base station knows which time slot the SYNC1 signal is allocated. Furthermore, the SYNC1 and RACH can be reallocated to another time slot if interference occurs. In an exemplary embodiment, on the downlink the SYNC signal may be superimposed on a BCH slot that contains unused resources.

In an exemplary embodiment, the SYNC1 signal may be superimposed on the RACH slot by adding the signals. Similarly, the SYNC signal may be superimposed on the BCH slot by adding the signals. It will be appreciated that the resulting signal may be superimposed with additional signals such as, for example, other traffic and control channels. Further, it will be appreciated that other encoding schemes may be implemented to superimpose the signals.

Fig. 3 illustrates the structure of an exemplary time slot 300, which could be either an uplink time slot or a downlink time slot. The time slot 300 includes a first data segment 302 separated from a second data segment 304 by a midamble 306. The signaling information (e.g., SYNC1 in the downlink or SYNC in the uplink) is superimposed on the slot at a time offset from the slot boundary. The time offset can be either fixed or variable. Preferably, the signaling information does not overlap with the pilot signal or midamble, since that may interfere with channel estimation for other mobile terminals transmitting in that slot.

Because mobile terminals transmitting in particular time slots may be located at different distances from the base station for the duration of a connection with the base station, bursts from the mobile may be displaced from the correct timing by a small timing error. Many base stations include a timing advance function that corrects this timing error by establishing a control loop with the mobile terminal. In systems with uplink synchronization, the accuracy of the timing advance is sufficient to assume that the timing error is virtually zero. However, if the base station has not yet established a control loop, there will be a non-zero timing error. In this case, the mobile may estimate when to transmit the SYNC1 signal to keep the timing error relatively small. The base station searches a window of time around the expected time location of a SYNC1 signal to capture SYNC1 transmissions with small timing errors. The time window will generally reflect the size of the cell.

In a network that implements the frame structure depicted in Fig. 2, a mobile terminal uses slightly modified synchronization procedures. Referring to Fig. 4, to perform an initial download synchronization, the mobile terminal cell searches the signal received from the base station for the occurrence of a valid SYNC signal. Typically, the search is implemented using a bank of matched filters tuned to receive candidate SYNC signals. Because the BCH is superimposed on the slot with the sync, when the mobile terminal detects a valid SYNC signal, the mobile terminal can immediately determine the position within the frame structure of the BCH. The mobile terminal determines the frame configuration from signaling information in the BCH that explicitly locates the position in the frame structure of the RACH and FACH. The mobile terminal can use this information to estimate the approximate location of the SYNC1 and upload slots. The mobile terminal can also use information on the BCH to approximate the desired power for transmission.

An exemplary initial upload synchronization sequence is illustrated in Fig. 5. First, the mobile terminal performs a download synchronization substantially as described above. Then the mobile terminal selects a random code SYNC1 to transmit to the base station in the time slot corresponding to the RACH. The SYNC1 code is transmitted at a desired power level estimated by the mobile terminal.

The base station receives the frame structure from the mobile terminal and scans the RACH slot and adjacent time slots for the occurrence of a valid SYNC1 signal. The base station estimates the mobile terminal's timing error based on the difference between the position within the frame structure of the detected SYNC1 signal and the expected position of the SYNC1 signal. The base station then estimates the difference between the expected power of the received SYNC1 signal and the actual power of the received SYNC1 signal. The base station then signals timing and power corrections to the mobile terminal on the FACH channel. The mobile terminal reads the timing and power correction information in the FACH channel, adjusts its timing and power accordingly, and prepares and transmits a random access burst in the designated RACH slot.

The uplink synchronization may be maintained using substantially the same procedures described in connection with the frame structure depicted in Fig. 1.

The increased flexibility provided by the frame structure depicted in Fig. 2 requires the base station to transmit additional signaling on the BCH so the mobile terminal can determine the uplink and downlink configuration and the location of the slots with SYNC and SYNC1. However, since this information changes only intermittently, updating the information does not unduly consume network resources.

Note that the SYNC1 signal and the corresponding random access signal are not necessarily transmitted simultaneously. As used herein, the term superimposed may also denote that the SYNC1 signal is superimposed on the received signal (at BS) to traffic from other mobile terminals using this slot. In general, the mobile terminal initiating the

SYNC1 is not already using this same slot, although this is not excluded.

In an exemplary embodiment, the SYNC1 signal needs to be transmitted only at initial setup or when the uplink synchronization information needs to be updated for reasons other than those described in this document. As used herein, the term initial setup means initiation of a packet transfer (or possibly of many packet transfers) in packet data mode or initiation of a connection in circuit switched mode.

In an exemplary embodiment, the receiver in the base station searches for a match between the received signal and the valid set of code words in the time location(s) in the time slot where the base station thinks the signal is located. Due to timing inaccuracies, the base station may be required to search a time window around the most likely location(s). Then, the base station determines a set of likely candidates for code words and locations. If the candidate slots are not empty, the base station estimates the time difference between at least one of the candidate's time locations and at least one of the predefined time locations. This time difference may be used for signaling the mobile terminal to adjust its transmission time so that the base station receives SYNC1 as close to the nominal location as possible.

In an exemplary embodiment, the SYNC1 signal may be chosen from a set of two or more signals, or code words, and may be transmitted in a fixed single location within the time slot (e.g., at a fixed offset from the beginning of the slot). In alternate embodiments, the code word may be chosen randomly, from a set of code words allocated to a specific cell, or from a set of code words allocated to a specific network, or a specific portion of a network. Further, multiple instances of the SYNC1 signal may be transmitted within the time slot, and these instances of SYNC1 may have different code words. The control channel with which SYNC1 is associated may be the RACH or another uplink control channel.

The present invention may be implemented in networks that employ either TDMA access techniques, CDMA access techniques, or hybrids thereof.

The present invention provides numerous advantages over existing TD-SCDMA communication networks. The invention allows flexible allocation of uplink and downlink slots within the frame structure. Additionally, time slots are not committed to a particular function (e.g, the DwPTS or UpPTS). Therefore, the slots with the RACH channel or the SYNC1 channel can be reallocated to avoid interference if necessary. Further, because the frame structure of the present invention positions the SYNC1 signal and the RACH are in the same slot, only trivial mapping between the slot where SYNC1 is located and the slot where RACH is located. Also, the combined SYNC1 and RACE can be reallocated together, while keeping the trivial mapping above.

What is claimed is:

1. A method for transmitting uplink synchronization information from at least one transmitter in a cellular digital radio communication system using a time division duplex multiple access technique, comprising the steps of:

selecting, at the transmitter, a first code word;

selecting, at the transmitter, a first time location within an uplink time slot;

superimposing the first code word on the first time location within the uplink time slot, wherein the uplink time slot contains resources for at least one physical control channel and at least one pilot signal; and

transmitting, from the transmitter, the first code word in the first time location.

2. The method of claim 1, wherein:

the physical control channel is the physical random access control channel.

3. The method of claim 1, wherein:

the first code word is selected randomly.

4. The method of claim 1, wherein:

the first time location corresponds to the RACH slot.

5. The method of claim 1, wherein:

the first code word is selected from a set of code words.

6. The method of claim 1, wherein:

the first time location is selected from a set of time locations.

7. The method of claim 1, wherein:
the multiple access method is code division multiple access.

8. The method of claim 1, wherein:
the multiple access method is time division multiple access.

9. The method of claim 1, wherein:
the first code word is selected from a set of code words allocated to a specific cell.

10. The method of claim 1, wherein:
the first code word is selected from a set of code words allocated to a network.

11. The method of claim 1, wherein:
the first time location is selected randomly.

12. The method of claim 1, wherein:
the first time location is selected from a set of time locations allocated to a specific cell.

13. The method of claim 1, wherein:
the first time location is selected from a set of time locations allocated to a network.

14. The method of claim 1, wherein:
the transmission of the uplink synchronization information does not overlap with at

least one of the transmissions of the pilot signals reserved by said mobile terminal.

15. The method of claim 1, further comprising the step of:

transmitting, from the transmitter, a second code word in the set of chosen time locations.

16. The method of claim 15, wherein:

at least two of the blocks of uplink synchronization information have different choices of code words.

17. A method of receiving uplink synchronization information from at least one transmitter in a cellular digital radio communication network using time division duplex multiple access, wherein the synchronization information is represented by a first code word superimposed on an uplink time slot transmitted in a predetermined time location within a frame structure, comprising at least the steps of:

searching for a match of the first code word in at least one time location in at least one time slot designated for the uplink; and

determining a possibly empty set of likely candidates for code words and locations, and if the set of candidates is not empty, then estimating the time difference between at least one of the candidates time locations and at least one of the predefined time locations.

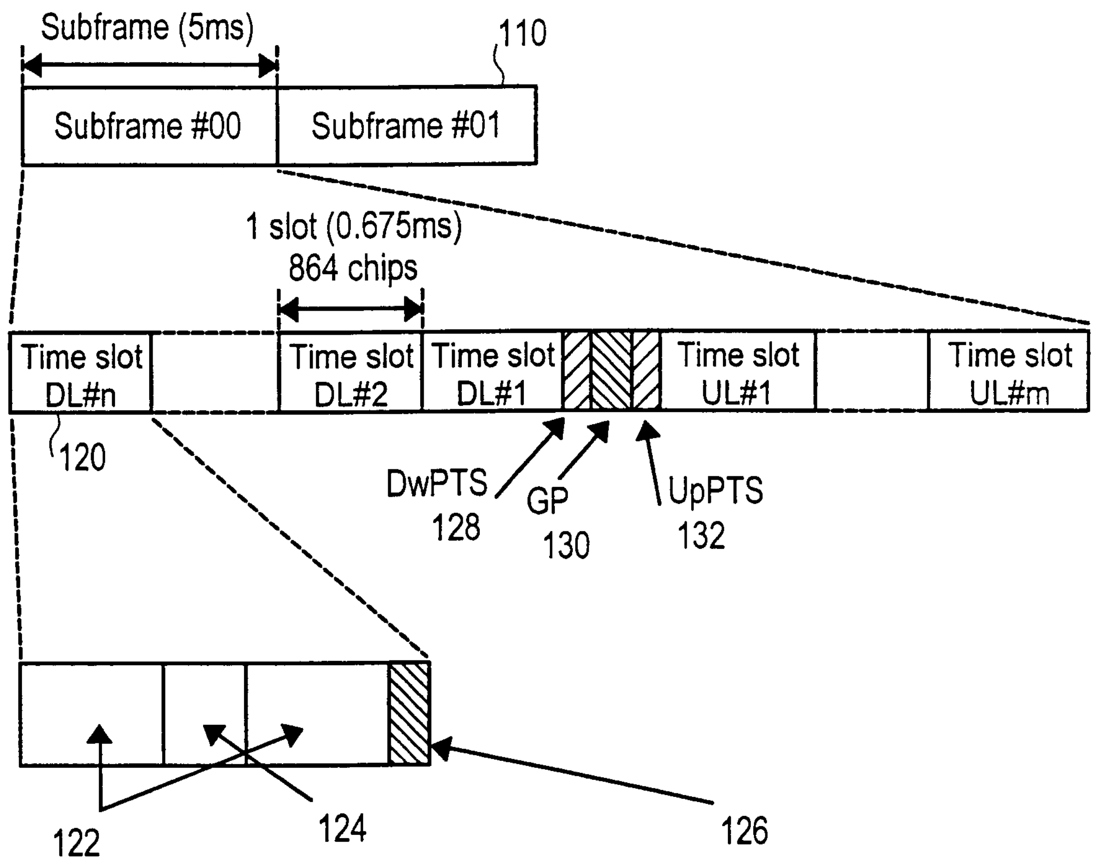
Subframe (5ms)
110
Subframe #00
Subframe #01
1 slot (0.675ms)
864 chips
Time slot DL#n
Time slot DL#2
Time slot DL#1
Time slot UL#1
Time slot UL#m
120
DwPTS 128
GP 130
UpPTS 132
122
124
126

FIG. 1

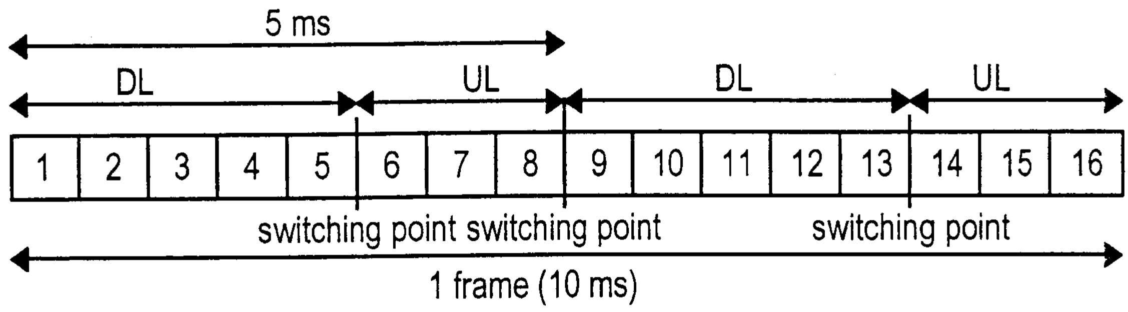
5 ms
DL
UL
DL
UL
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
switching point
switching point
switching point
1 frame (10 ms)

FIG. 2

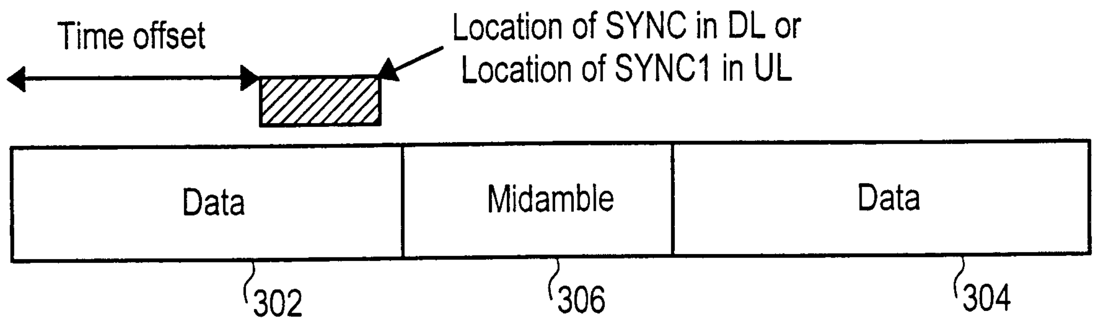
Time offset
Location of SYNC in DL or
Location of SYNC1 in UL
Data
Midamble
Data
302
306
304

FIG. 3

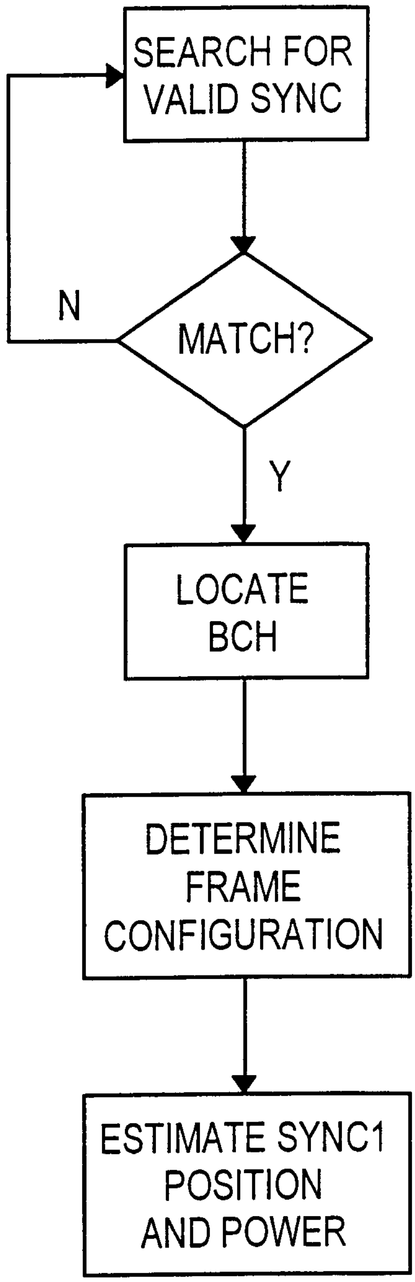
SEARCH FOR VALID SYNC
MATCH?
N
Y
LOCATE BCH
DETERMINE FRAME CONFIGURATION
ESTIMATE SYNC1 POSITION AND POWER

FIG. 4

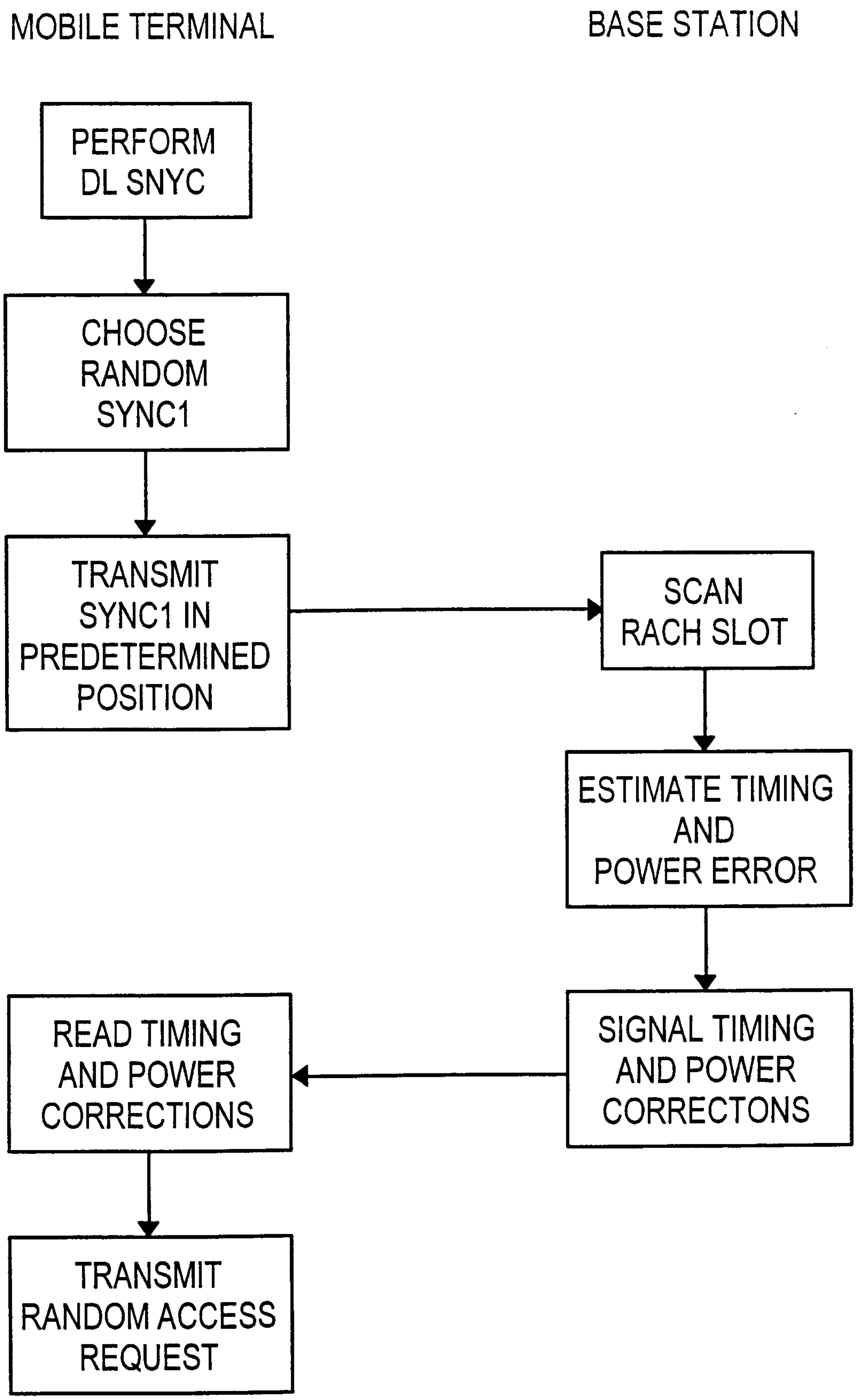
MOBILE TERMINAL
BASE STATION
PERFORM DL SNYC
CHOOSE RANDOM SYNC1
TRANSMIT SYNC1 IN PREDETERMINED POSITION
SCAN RACH SLOT
ESTIMATE TIMING AND POWER ERROR
SIGNAL TIMING AND POWER CORRECTONS
READ TIMING AND POWER CORRECTIONS
TRANSMIT RANDOM ACCESS REQUEST

FIG. 5