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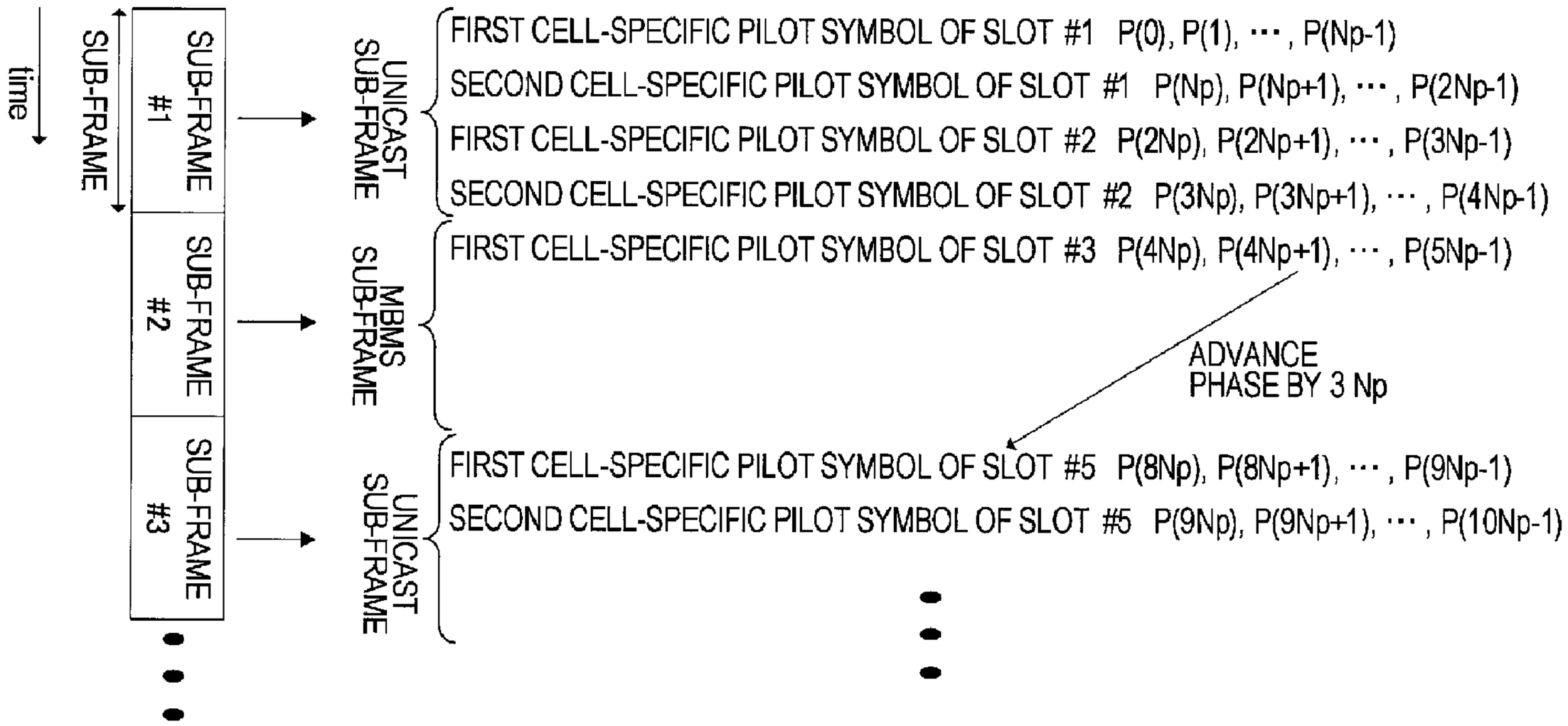
(54) Titre : PROCEDE DE TRANSMISSION DE SIGNAL PILOTE, ET STATION DE BASE, STATION MOBILE ET SYSTEME CELLULAIRE AUQUEL CE PROCEDE EST APPLIQUE

(54) Title: PILOT SIGNAL TRANSMITTING METHOD, BASE STATION, MOBILE STATION AND CELLULAR SYSTEM TO WHICH THE METHOD IS APPLIED



(57) Abrégé/Abstract:
A pilot signal transmitting method, which achieves an appropriate cell search without increasing in scale or complicating the mobile station structure, is provided along with a base station, a mobile station and a cellular system to which that method is applied. In a cell-specific pilot signal transmitting method for use in a mobile communication system that comprises a base station and a mobile station wireless communicating with the base station in the cell of a wireless communication area formed by the base station and that can mix and then transmit unicast data and broadcast/multicast data as downstream data from the base station to the mobile station, the difference between the start phase of a cell-specific pilot signal transmitted in a subframe in which the base station

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(57) Abrégé(suite)/Abstract(continued):
transmits the unicast data and the start phase of a cell-specific pilot signal transmitted in the next subframe is equal to the difference between the start phase of a cell-specific pilot signal transmitted in a subframe in which the base station transmits the broadcast/multicast data and the start phase of a cell-specific pilot signal transmitted in the next subframe.

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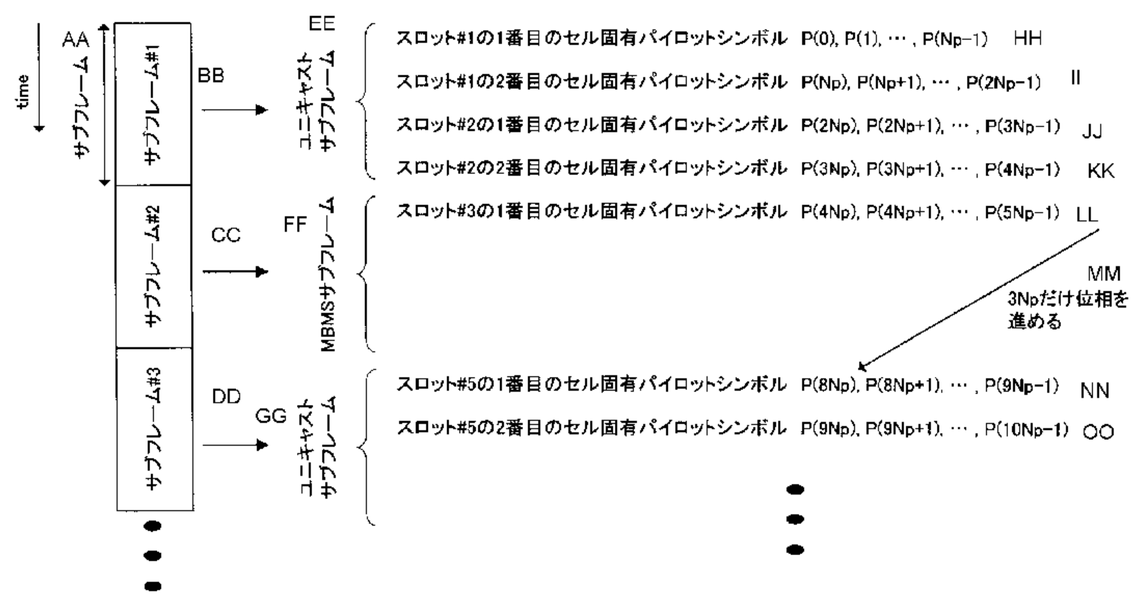
(54) Title: PILOT SIGNAL TRANSMITTING METHOD, AND BASE STATION, MOBILE STATION AND CELLULAR SYSTEM TO WHICH THAT METHOD IS APPLIED

(54) 発明の名称: パイロット信号送信方法，これを適用する基地局，移動局及びセルラーシステム

[図6]



AA SUBFRAMES
BB SUBFRAME #1
CC SUBFRAME #2
DD SUBFRAME #3
EE UNICAST SUBFRAME
FF MBMS SUBFRAME
GG UNICAST SUBFRAME
HH FIRST CELL-SPECIFIC PILOT SYMBOLS P(0), P(1),...,P(Np - 1) OF SLOT #1
II SECOND CELL-SPECIFIC PILOT SYMBOLS P(Np), P(Np+1),...,P(2Np-1) OF SLOT #1
JJ FIRST CELL-SPECIFIC PILOT SYMBOLS P(2Np), P(2Np+1),...,P(3Np-1) OF SLOT #2
KK SECOND CELL-SPECIFIC PILOT SYMBOLS P(3Np), P(3Np+1),...,P(4Np-1) OF SLOT #2
LL FIRST CELL-SPECIFIC PILOT SYMBOLS P(4Np), P(4Np+1),...,P(5Np-1) OF SLOT #3
MM ADVANCE PHASE BY 3Np
NN FIRST CELL-SPECIFIC PILOT SYMBOLS P(8Np), P(8Np+1),...,P(9Np-1) OF SLOT #5
OO SECOND CELL-SPECIFIC PILOT SYMBOLS P(9Np), P(9Np+1),...,P(10Np-1) OF SLOT #5

(57) Abstract: A pilot signal transmitting method, which achieves an appropriate cell search without increasing in scale or complicating the mobile station structure, is provided along with a base station, a mobile station and a cellular system to which that method is applied. In a cell-specific pilot signal transmitting method for use in a mobile communication system that comprises a base station and a mobile station wireless communicating with the base station in the cell of a wireless communication area formed by the base station and that can mix and then transmit

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unicast data and broadcast/multicast data as downstream data from the base station to the mobile station, the difference between the start phase of a cell-specific pilot signal transmitted in a subframe in which the base station transmits the unicast data and the start phase of a cell-specific pilot signal transmitted in the next subframe is equal to the difference between the start phase of a cell-specific pilot signal transmitted in a subframe in which the base station transmits the broadcast/multicast data and the start phase of a cell-specific pilot signal transmitted in the next subframe.

(57) 要約: 移動局の構成を大規模化或いは複雑化せず，適切なセルサーチ処理を実現できるパイロット信号送信方法，これを適用する基地局，移動局，セルラーシステムを提供する。基地局と前記基地局が形成する無線通信エリアのセルにて前記基地局と無線通信を行う移動局を有し，前記基地局から前記移動局への下りデータとして，ユニキャストデータとブロードキャスト・マルチキャストデータを混在して送信しうる移動通信システムでのセル固有パイロット信号送信方法にて，前記基地局が前記ユニキャストデータを送信したサブフレームにて送信したセル固有パイロット信号の開始位相と次のサブフレームにて送信するセル固有パイロット信号の開始位相の差と，前記ブロードキャスト・マルチキャストデータを送信したサブフレームにて送信したセル固有パイロット信号の開始位相と次のサブフレームにて送信するセル固有パイロット信号の開始位相の差を同じとしたことを特徴とする。

PILOT SIGNAL TRANSMITTING METHOD, BASE STATION, MOBILE STATION AND CELLULAR SYSTEM TO WHICH THE METHOD IS APPLIED

TECHNICAL FIELD

[0001] The present invention relates to a pilot signal transmitting method, and a base station, mobile station and cellular system to which this method is applied.

BACKGROUND

[0002] In a cellular system, a mobile station normally performs a cell search processing to seek a cell which connects a radio link.

[0003] The cell search is executed using a synchronization channel (SCH) included in a radio frame in a downstream link. In addition to the synchronization channel, a cell-specific pilot channel and a broadcast channel (BCH) may also be used (Non-patent Document 1: 3GPP TR 25. 814 V7.0.0). An example of the cell search will be described with reference to the drawings.

[0004] Fig. 1 indicates an example of a configuration of a radio frame transmitted from a base station transmission apparatus.

[0005] As Fig. 1 indicates, the radio frame is constructed by various channels multiplexed in a two-dimensional direction of time and frequency. In the example in Fig. 1, the radio frame has 10 sub-frames, SF1 to SF10, in the time direction, and each sub-frame SF consists of two slots: the first half slot and the latter half slot.

[0006] In each slot, a resource uniquely determined by a symbol position (time) and a sub-carrier position (frequency) is called a "resource element".

[0007] The various channels multiplexed in a slot includes a primary synchronization channel (P-SCH), a secondary synchronization channel (S-SCH) and a pilot signal channel (P-CH).

[0008] The primary synchronization channel (P-SCH) has a common pattern for all the cells, and is time-multiplexed in the end symbols of the first half slot #0 of the first sub-frame SF1 and of the first half slot #10 of the sixth sub-

frame SF6 respectively.

[0009] The secondary synchronization channel (S-SCH) has a pattern, which is specific to a cell ID group, and which is a group of cell IDs assigned to each cell in advance. The secondary synchronization channel (S-SCH) is time-multiplexed in the second symbol from the respective ends of the first half slot #0 of the first sub-frame SF1 and of the first half slot #10 of the sixth sub-frame SF6.

[0010] The pilot signal channel (P-CH) also has a cell-specific scramble code which is information specific to a cell, and is time-multiplexed in the first symbol and the fifth symbol of each slot (#0, #1, #2, ...).

[0011] The cell ID assigned to each cell and the cell-specific scramble code correspond one-to-one, so the mobile station can determine a cell ID of a cell in which the mobile station is located by specifying the cell-specific scramble code.

[0012] For the cell-specific scramble code, a method of using a sequence of a base station-specific pseudo-random number sequence multiplied by a phase rotation sequence, which is orthogonal between sectors within a same base station, or a method of using a generalized chirp like sequence for the pseudo-random number sequence, for example, may be used.

[0013] Fig. 2 illustrates a cell search processing procedure performed in a mobile station. When the radio format depicted in Fig. 1 is received from a base station, the mobile station detects the correlation with a replica of a time signal of the primary synchronization channel (P-SCH), which is a known pattern, as a processing in the first step, and decides a timing indicating the maximum correlation value, for example, as the sub-frame timing (step S1).

[0014] As the second step, fast Fourier transform (FFT) processing is performed at the timing detected in the first step, so that the received radio format is transformed into a frequency domain signal, and the secondary synchronization channel (S-SCH) is extracted from the frequency domain signal. Then correlation of the extracted secondary

synchronization channel (S-SCH) and each candidate secondary synchronization channel sequence replica is determined, and a candidate secondary synchronization channel sequence having a maximum correlation value, for example, is decided as a detected secondary synchronization channel sequence. A cell ID group is determined by the detected secondary synchronization channel (step S2).

[0015] As the third step, fast Fourier transform (FFT) processing is performed at the timing detected in the first step so that the signal is transformed into a frequency domain signal, and the pilot signal channel (P-CH) is extracted from the transferred frequency domain. Then the extracted pilot signal channel (P-CH) is correlated with a scramble code replica corresponding to each candidate cell ID included in the cell ID group detected in the second step, and a cell ID corresponding to a candidate scramble code indicating a maximum correlation value, for example, is decided as a detected cell ID (step S3). By this, a cell in which the mobile station is located may be specified.

[0016] In the case of 3GPP (Third Generation Partnership Project), specifications of the multimedia broadcast/multicast service (MBMS) are under consideration, aiming at standardizing the next generation portable telephone communication.

[0017] For example, MBMS data is time-multiplexed with the unicast data in sub-frame units. The Non-patent Document 1 describes a method for improving the reception quality by using a guard interval, which is longer than the guard interval used for unicast data, transmitting a same data from a plurality of cells at a same timing using a same frequency, and combining received signals at a mobile station side.

[0018] This is called a "single frequency network". In this case, a same cell-common pilot signal among cells is transmitted for demodulating the same MBMS data transmitted from a plurality of cells.

[0019] The Non-patent Document 2 describes that the control signal for a unicast is multiplexed with a sub-frame

allocated to MBMS data (hereafter called MBMS sub-frame), and a cell-specific pilot signal having a different pattern in each cell for unicast is multiplexed with the MBMS sub-frame for demodulating the control signal for unicast and measuring CQI.

[0020] A configuration of a pilot signal of an MBMS sub-frame is also described in Non-patent Document 3. According to this configuration, a cell-specific pilot signal for unicast is multiplexed only with a first symbol of an MBMS sub-frame.

[0021] In the case of time-multiplexing an MBMS sub-frame, as mentioned above, sub-frames having different guard interval lengths are time-multiplexed. In an initial cell search which is executed when power of the mobile station is turned ON, a problem occurs in the above mentioned third step of a cell search, since information on the guard interval length of the receive sub-frame is not available.

[0022] This problem is described in detail in Non-patent Document 4. One means for solving this problem is to improve a method for attaching a guard interval of MBMS sub-frames, as described in the Non-patent Document 4. Another method is using, as indicated in non-patent Document 5, only pilot signals in a sub-frame in which a synchronization channel has been multiplexed in the initial cell search.

Non-patent Document 1: 3GPP TR 25. 814 V 7.0.0

Non-patent Document 2: 3GPP TSG-RAN WG1, R1-060372, "Multiplexing of Unicast Pilot and Control Channels in E-MBMS for E-UTRA Downlink", Texas Instruments

Non-patent Document 3: 3GPP TSG-RAN WG1, R1-070383, "Reference Signals for Mixed Carrier MBMS", Nokia

Non-patent Document 4: 3GPP TSG-RAN WG1, R1-060563, "Channel Design and Long CP Sub-frame Structure for Initial Cell Search", Fujitsu

Non-patent Document 5: 3GPP TSG RAN WG1, R1-063304, "Three-step Cell Search Method for E-UTRA", NTT DoCoMo, Institute for Infocomm Research, Mitsubishi Electric, Panasonic, Toshiba Corporation.

[0023] If MBMS sub-frames are multiplexed in a radio

frame, a number of resource elements of cell-specific pilot signals in one radio frame decreases, compared with a case of assigning only unicast sub-frames to the radio frame (this relationship may be reversed in some cases).

[0024] The number of resource elements of cell-specific pilot signals in one radio frame also depends on the number of MBMS sub-frames that are multiplexed. For example, if a cycle of scramble codes of cell-specific pilot signals is one radio frame, then the phase of the scramble code at each transmission timing of the cell-specific pilot signal changes by multiplexing the MBMS sub-frames.

[0025] Fig. 3 illustrates a case of allocating all the sub-frames of a radio frame to unicast (case 1), and a case of allocating the sub-frames #1 and #4 to MBMS (case 2) as examples.

[0026] In Fig. 3, the column "phase of cell-specific scramble code" is based on the assumption that the cell-specific scramble code is a cell-specific pilot signal, and resource elements allocated to the cell-specific pilot signal are listed from one at the lower frequency side, and are indicated by a phase of the cell-specific scramble code allocated to the resource element at the lowest frequency side at each transmission timing of the cell-specific pilot signal.

[0027] Np denotes a number of resource elements allocated to the cell-specific pilot signal in each symbol of the cell-specific pilot signal.

[0028] In case 1, where all the sub-frames are allocated to unicast, the phase shift of the cell-specific scramble code does not occur.

[0029] In case 2, on the other hand, the sub-frames #1 and #4 are allocated to MBMS, so a phase shift of the cell-specific scramble code occurs.

[0030] As the Non-patent Document 5 indicates, when correlation is determined using the cell-specific pilot signals in the sub-frames #0 and #5 in which the synchronization channel is multiplexed, if the phase shift of cell-specific scramble codes has occurred, it is

inevitable to perform blind detection since the phases of cell-specific pilot signals in sub-frame #5 are unknown, therefore the processing volume increases and detection probability deteriorates.

DISCLOSURE OF THE INVENTION

[0031] With the foregoing in view, it is an object of some embodiments of the present invention to simplify correlation detection in a mobile station. It is another object of some embodiments of the present invention to control the change amount of a transmission start phase of a pilot signal to a predetermined value among (sub) frames.

[0032] It is still another object of some embodiments to provide a pilot signal transmitting method to perform correlation processing when unicast data and MBMS sub-frames are multiplexed in radio frames, causing no phase shift of a cell-specific scramble codes at each timing of a cell-specific pilot signal symbol, and therefore to implement appropriate cell search processing without increasing in scale or complicating the configuration of the mobile station, along with a base station, a mobile station and a cellular station to which this method is applied.

[0033] In order to attain the above objects, this invention is characterized in that a transmitting method used in a mobile communication system a base station are used. In other words, in some aspects, the present invention provides a cell-specific pilot signal transmitting method used in a mobile communication system, which has a base station and a mobile station that

performs radio communication with the base station in a cell of a radio communication area formed by the base station, and which mixes and transmits unicast data and broadcast/multicast data as downstream data from the base station to the mobile station, wherein a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station has transmitted the unicast data and a start phase of a cell-specific pilot signal transmitted in a next sub-frame is equal to a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station transmitted the broadcast/multicast data and a start phase of a cell-specific pilot signal transmitted in a next sub-frame.

[0034] Further, a base station according to the present invention that forms a radio communication area for communicating with a mobile station in a mobile communication system that mixes and transmits unicast data and broadcast/multicast data, includes a phase control unit which controls to equalize a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station has transmitted said unicast data and a start phase of a cell-specific pilot signal to be transmitted in a next sub-frame and a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station has transmitted the broadcast/multicast data and a start phase of a cell-specific pilot signal to be transmitted in the next sub-frame.

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[0034a] Further there is provided a mobile station that communicates with a base station in a mobile communication system transmitting unicast data and broadcast/multicast data, the mobile station comprising: a receive unit to receive a cell-specific pilot signal controlled by the base station so that a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station transmitted the unicast data and a start phase of a cell-specific pilot signal to be transmitted in a next sub-frame and a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station transmitted the broadcast/multicast data and a start phase of a cell-specific pilot signal to be transmitted in a next sub-frame are a same predetermined amount.

[0034b] Further there is provided a mobile communication system including a base station and a mobile station in which the base station, transmits unicast data and broadcast/multicast data to the mobile station, wherein the base station comprises: a phase control unit to control for setting a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station transmitted the unicast data and a start phase of a cell-specific pilot signal to be transmitted in a next sub-frame to be equal to a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station transmitted the broadcast/multicast data and a start phase of a cell-specific pilot signal to be transmitted in a next sub-frame, and wherein the mobile station comprises: a receive unit to receive the cell-specific pilot signal transmitted from the base station.

[0034c] Further there is provided a pilot signal transmitting method in a mobile communication system that has a base station and a mobile station that performs radio communication with the base station in a cell of a radio communication area formed by the base station, wherein in the case when a difference between a transmission start phase of the pilot signal to be transmitted and a transmission end phase thereof is varied between a first unit transmission period and a second unit transmission period, the base station controls the difference between the transmission start phase of the pilot signal in the first unit transmission period, and the transmission start phase of the pilot signal in the second unit transmission period is controlled to be a predetermined difference which is greater than the difference between the transmission start phase and the transmission end phase.

[0035] According to the present invention having the above characteristics, in a system which mixes and transmits unicast data and MBMS data as downstream data, correlation processing is performed at each timing of a cell-specific pilot signal symbol causing no phase shift of cell-specific scramble codes, even if a number of resource elements allocated to a cell-specific pilot signal in a radio frame changes depending on a number of MBMS sub-frames which are allocated to the radio frame.

[0036] Therefore appropriate cell research processing is implemented without increasing in scale or complicating the configuration of the mobile station, and the mobile station can be simplified and characteristics thereof during cell search processing can be improved, therefore the present invention will be extremely useful in the mobile communication field.

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BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is an example of a configuration of a radio frame transmitted from a base station transmission apparatus;

Fig. 2 illustrates a cell search processing procedure in a mobile station;

Fig. 3 illustrates a case of allocating all the sub-frames of a radio frame to unicast and a case of allocating the sub-frames to MBMS as examples;

Fig. 4 is a block diagram depicting a configuration of the key portions of a base station transmission apparatus according to the present invention;

Fig. 5 is an example of a configuration of a radio frame, including an MBMS sub-frame, depicted by a two-dimensional diagram of time and frequency;

Fig. 6 is an example where the phase control unit controls phase of cell-specific scramble code as the same in cell specific pilot signal symbols;

Fig. 7 is a block diagram depicting a configuration of the key portions of a mobile station in an OFDM communication system;

Fig. 8 is a diagram depicting the second embodiment;

Fig. 9 illustrates the phases of cell-specific pilot signals in each frequency band according to the second embodiment;

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Fig. 10 illustrates a configuration example of a radio frame according to the third embodiment; and

Fig. 11 is another example of a radio frame according to the third embodiment.

DESCRIPTION OF EMBODIMENTS

[0037] Embodiments of the present invention will now be described with reference to the drawings.

[First embodiment]

Fig. 4 is a block diagram depicting a configuration of the key portions of a base station transmission apparatus according to the present invention.

[0038] The base station transmission apparatus illustrated in Fig. 4 includes a data selection unit 1, a cell-specific pilot signal channel sequence storage unit 2, a cell common pilot signal sequence storage unit 3, a pilot signal selection unit 4, phase control unit 5, a primary synchronization channel storage unit 6, a secondary synchronization channel storage unit 7, a channel multiplexing unit 8, a serial/parallel conversion processing unit 9, a IFFT processing unit 10, a guard interval (GI) insertion unit 11, a radio processing unit 12, and a transmission antenna 13.

[0039] The data selection unit 1 selects unicast data A or MBMS data B according to scheduling, and sends one sub-frame of data to the channel multiplexing unit 8. If MBMS data B is selected by the data selection unit 1, an instruction of phase control is output to the phase control unit 5.

[0040] The pilot signal selection unit 4 changes a selection method for selecting a cell-specific pilot signal channel sequence AA or cell-common pilot signal channel sequence AB according to the type of transmission data of the sub-frame, and reads pilot signals from a corresponding storage unit 2 or 3. If the data type is MBMS, the pilot signal selection unit 4 reads one MBMS sub-frame of cell-specific pilot signals N_{s_m} and one MBMS sub-frame of cell-common pilot signals N_{common} from the cell-specific pilot signal channel sequence storage unit 2 and cell-common pilot signal channel sequence storage channel sequence storage unit 3 respectively. If the data type is unicast data, one unicast sub-frame of cell-specific pilot signals N_{s_u} are read.

[0041] In this case, current phases of the cell-specific pilot signal channel sequence storage unit 2 and cell-common pilot signal channel sequence storage unit 3 are advanced by

the amount of the phase which was read.

[0042] If the phase control is instructed, the phase control unit 5 advances the current phase of the cell-specific pilot signal channel sequence storage unit 2 by the amount of (phase amount corresponding to N_{s_u}) - (phase amount corresponding to N_{s_m}).

[0043] In other words, phase control is performed so that the difference between the start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station transmitted the unicast data and the start phase of the cell-specific pilot signal transmitted in the next sub-frame is equal to the difference between the start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station transmitted the broadcast/multicast data and the start phase of a cell-specific pilot signal transmitted in the next sub-frame.

[0044] In other words, in a pilot signal (e.g. cell-specific pilot signal) transmitting method in a mobile communication system that has a base station and a mobile station which performs radio communication with the base station in a cell of a radio communication area formed by the base station, in the case when the difference between the transmission start phase of the pilot signal to be transmitted and a transmission end phase is different between a first unit transmission period (e.g. sub-frame in which the base station transmits unicast data) and a second unit transmission period (e.g. sub-frame in which the base station transmits MBMS data), the base station controls the difference between the transmission start phase of the pilot signal in the first unit transmission period and the transmission start phase of the pilot signal in the second unit transmission period to be a predetermined difference which is greater than the difference between the transmission start phase and the transmission end phase (in the above example, phase is advances by (phase amount corresponding to N_{s_u}) - (phase amount corresponding to N_{s_m})).

[0045] The channel multiplexing unit 8 multiplexes each channel signal (modulation data) of various channels (e.g.

data channel, pilot signal channel, synchronization channel) to be transmitted to the mobile station UE (User Equipment), and the serial/parallel conversion processing unit 9 (may be abbreviated to S/P conversion unit herein below) performs serial/parallel conversion for the signal multiplexed by the channel multiplexing unit 8 (Nc number of modulation data) and positions each converted data in each sub-carrier (mapping).

[0046] Fig. 5 illustrates an example of a configuration of a radio frame, including an MBMS sub-frame, depicted by a two-dimensional diagram of time and frequency. In this example, one radio frame (RF) consists of 10 sub-frames (SF), and one sub-frame consists of two slots (SL).

[0047] One slot includes seven symbols (SB) in the case of a unicast sub-frame, and includes six symbols in the case of an MBMS sub-frame 100 since the guard interval is long.

[0048] A cell-specific pilot signal AA is multiplexed in the first symbol a and the fifth symbol b of each slot of a unicast sub-frame at a six sub-carrier interval. The position of the fifth symbol b in the frequency direction is shifted by three sub-carriers from the position of the first symbol a in the frequency direction.

[0049] In the case of the MBMS sub-frame 100, on the other hand, a cell-specific pilot signal AA is multiplexed only in a first symbol c in the first half slot at a six sub-carrier interval.

[0050] A cell-common pilot signal AB is positioned in the second symbol d and the fifth symbol e of each slot of the MBMS sub-frame 100 at a two sub-carrier interval. The position of the fifth symbol in the frequency direction is shifted by one sub-carrier from the position of the second symbol in the frequency direction.

[0051] A cell-specific scramble code to be transmitted as a cell-specific pilot signal channel AA, however, is controlled by the phase control unit 5 so that the start phase difference of a cell-specific pilot signal between each sub-frame becomes a predetermined amount. Fig. 6 illustrates an example.

[0052] In Fig. 6, the first sub-frame SF (#1) and the third sub-frame (#3) of the radio frame are allocated to unicast, and the second sub-frame (#2) is allocated to MBMS (hereafter the Xth sub-frame is denoted as sub-frame (#X)).

[0053] Np is a number of resource elements allocated to a cell-specific pilot signal channel in each cell-specific pilot signal symbol. In the example in Fig. 6, a number of cell-specific pilot signal symbols of one unicast sub-frame is 4, so N_{s_u} = 4 Np, and a number of cell-specific pilot signal symbols of one MBMS sub-frame is 1, so N_{s_u} = Np.

[0054] Cell-specific scramble codes are positioned, from the low frequency side, to the resource elements allocated to the cell-specific pilot signal of the cell-specific pilot signal symbol which is transmitted first in the radio frame.

[0055] In the sub-frame (#2) allocated to MBMS, a cell-specific pilot signal is multiplexed only in the first symbol of the first half slot. Therefore phase of a cell-specific scramble code, which is allocated to the lowest frequency side of the next cell-specific pilot signal, is advanced by 3 Np by the phase control unit 5, and becomes P (8 NP).

[0056] Hereafter, each time an MBMS sub-frame is multiplexed, the phase of the cell-specific scramble code is advanced in the same manner. Because of this, the phase of the first cell-specific pilot signal symbol of each sub-frame is determined whether or not an MBMS sub-frame is present in the radio frame.

[0057] Referring back to Fig. 4, the IFFT processing unit 10 IFFT-processes the modulated data positioned in each sub-carrier, in Nc units, which corresponds to the number of sub-carriers, and converts it into time domain signals.

[0058] The guard interval insertion unit 11 inserts a guard interval in the time domain signals.

[0059] The radio processing unit 12 performs a required radio processing, such as frequency-converting the signals after the guard interval is inserted into predetermined radio signals (up-convert), and transmits the radio signals to a propagation path via the transmission antenna 13.

[0060] Now the configuration and operation of a mobile station corresponding to the above mentioned base station will be described.

[0061] Fig. 7 is a block diagram depicting a configuration of the key portions of a mobile station in an OFDM communication system. The mobile station illustrated in Fig. 7 comprises, for example, a receive antenna unit 20, a radio processing unit 21, a first step processing unit 200, a second step processing unit 210, a third step processing unit 220, a guard interval removal unit 22 and an FFT processing unit 23.

[0062] The first step processing unit 200 has a first synchronization channel replica signal storage unit 201, a correlation processing unit 202, a time averaging unit 203 and a sub-frame timing detection unit 204. The second step processing unit 210 has a secondary synchronization channel extraction unit 211, a correlation processing unit 212, a candidate secondary synchronization code storage unit 213, a time averaging unit 214, and a secondary synchronization code radio frame timing detection unit 215. The third step processing unit 230 has a cell-specific pilot signal channel extraction unit 231, a candidate cell-specific scramble code storage unit 232, a phase control unit 233, a correlation processing unit 234, a time averaging unit 235 and a cell-specific scramble code detection unit 236.

[0063] Now the receive processing of the mobile station having this configuration will be described.

[0064] The receive antenna unit 20 receives a radio signal from the above mentioned base station BS, and the radio processing unit 21 performs the required radio receive processing, such as down convert processing, for the radio signals received by the receive antenna unit 20.

[0065] As a first step processing of cell search by the first step processing unit 200, a sub-frame timing is synchronously detected based on the correlation of the receive signal from the radio processing unit 21 and a replica signal of the primary synchronization channel (P-SCH), which is a known pattern (Fig. 2: step S1).

[0066] For this, in the first step processing unit 200, the primary synchronization channel replica signal storage unit 201 has stored replica signals of the primary synchronization channel in advance, and the correlation processing unit 202 determines correlation of the receive signal and the replica signal stored in the primary synchronization channel replica signal storage unit 201.

[0067] This correlation processing result by the correlation processing unit 202 is time-averaged by the time averaging unit 203, and is input to the sub-frame timing detection unit 204. The sub-frame timing detection unit 204 detects the sub-frame timing of the receive signal based on the correlation processing result by the correlation processing unit 202. For example, the timing at which the correlation is maximum can be detected as the sub-frame timing.

[0068] As the second step processing of cell search (Fig. 2: step S2), the second step processing unit 210 performs fast Fourier transform (FFT) processing based on the sub-frame timing detected in the first step processing unit 200, as mentioned above, extracts the secondary synchronization channel, and detects the secondary synchronization code and frame timing.

[0069] For this, the guard interval removal unit 22 removes the guard intervals inserted in the receive signals, which are radio-processed by the receive processing unit 21 based on the sub-frame timing detected by the sub-frame timing detection unit 204 of the first step processing unit 200.

[0070] The FFT processing unit 23 converts the receive signals in the time domain into signals in the frequency domain by performing FFT processing on valid signals after removing the guard intervals using a predetermined time block (at least the time of valid symbol length), that is, using an FFT window.

[0071] The secondary synchronization channel extraction unit 210 extracts resource elements in which the secondary synchronization channel is multiplexed, from the frequency

domain signal after the above mentioned FFT processing by the FFT processing unit 23. On the other hand, candidate secondary synchronization codes to be used for the correlation processing in the correlation processing unit 212 are stored in the secondary synchronization code storage unit 213 in advance. The correlation processing unit 212 determines correlation of the secondary synchronization channel extracted by the secondary synchronization channel extraction unit 211 and the candidate secondary synchronization codes stored in the candidate secondary synchronization code storage unit 213.

[0072] The output of the correlation processing unit 212 is averaged by the time averaging unit 214, and the secondary synchronization code radio frame timing detection unit 215 detects a secondary synchronization code and a radio frame timing based on the correlation processing result in the correlation processing unit 212. For example, a candidate secondary synchronization code having the maximum correlation can be decided as the detected secondary synchronization code. By this, a cell group is determined.

[0073] The third step processing unit 220 performs cell-specific pilot signal detection processing (Fig. 2: step S3), and the receive signal after FFT processing is input to the cell-specific pilot signal channel extraction unit 221. The cell-specific pilot signal channel extraction unit 221 extracts a resource element in which a cell-specific pilot signal is multiplexed from the frequency domain signals after the FFT processing by the FFT processing unit 23.

[0074] The candidate cell-specific scramble code storage unit 223 has stored replicas of candidate cell-specific scramble codes used for the correlation processing by correlation processing unit 224.

[0075] The correlation processing unit 224 determines correlation of a cell-specific pilot signal extracted by the cell-specific pilot signal channel extraction unit 221 and a candidate cell-specific scramble code replica stored in the candidate cell-specific scramble code storage unit 222.

[0076] The output of the correlation processing unit 224

is time-averaged by the time averaging unit 225, and the cell-specific scramble code detection unit 226 detects a cell-specific scramble code based on the correlation processing result in the correlation processing unit 224. For example, a candidate cell-specific scramble code having the maximum correlation can be decided as the detected cell-specific scramble code. By this, a cell in which the mobile station is located is specified as a result of cell search.

[Second embodiment]

The second embodiment is an example when the first embodiment is applied to a system which can transmit downstream signals using one of a plurality of frequency bands. The configuration of the base station and configuration of the mobile system are basically the same as the configurations illustrated in Fig. 4 and Fig. 7, which are described above.

[0077] Fig. 8 is a diagram depicting the second embodiment, and illustrates case I having 1200 sub-carriers, case II having 600 sub-carriers, case III having 300 sub-carriers, case IV having 144 sub-carriers, and case V having 72 sub-carriers, as the frequency bands.

[0078] A characteristic of the second embodiment is that a synchronization channel SCH is transmitted with a bandwidth W, which is equal to the minimum frequency band of 72 sub-carriers at the center, for all the cases of frequency bands I to V having a plurality of sub-carriers.

[0079] Fig. 9 illustrates the phases of cell-specific pilot signals in each frequency band according to the second embodiment. In the case of an MBMS sub-frame being multiplexed as well, the phase of the cell-specific pilot signal at each transmission timing is adjusted by the phase control unit 5 (see Fig. 4), as illustrated in Fig. 9.

[0080] Regardless which frequency band is used, the phase of the cell-specific pilot signal is always the same in band W of the center 72 sub-carriers.

[0081] In the initial cell search, a frequency band of the receive signals is unknown, therefore cell search is performed by receiving only signals having bandwidth W,

which is equal to the minimum frequency band. In the radio processing unit 21, signals having a bandwidth which is equal to the minimum frequency band are received using an analog filter. This reception may be performed after the radio processing unit 21 using a digital filter. Or the reception may be performed both in and after the radio processing unit 21.

[0082] The first step S1 and second step S2 of the cell search described in the first embodiment are performed to detect a sub-frame timing, cell ID group and radio frame timing. As mentioned above, in the synchronization channel SCH the signals are transmitted, in any frequency band, at the center of the frequency band, having a bandwidth W, which is equal to the minimum frequency band, so even if the frequency band is unknown, the first step S1 and second step S2 of the cell search can be executed using the synchronization channel SCH.

[0083] Then the third step S3 of the cell search described in the first embodiment is performed, and cell-specific scramble codes are detected. In this case, the phase at each transmission timing of the cell-specific pilot signal does not depend on which frequency band is used, and does not depend on whether or not an MBMS sub-frame is multiplexed, so the mobile station can detect the cell-specific scramble codes without knowing which frequency band is used, and without causing a phase shift of a cell-specific pilot signal by multiplexing an MBMS sub-frame.

[Third embodiment]

The third embodiment is also applied based on the first embodiment, and the base station transmission apparatus and mobile station have the same configuration as the configuration described in the first embodiment.

[0084] The third embodiment is a case when a cell-specific pilot signal in an MBMS sub-frame is transmitted only in a limited part of the bands.

[0085] This configuration is applied to a case when a unicast control signal is transmitted in an MBMS sub-frame only in a limited part of the bands.

[0086] Fig. 10 illustrates a configuration example of a radio frame according to the third embodiment. In other words, in the example illustrated in Fig. 10, the sub-frames #0 and #2 are unicast sub-frames, and the sub-frame #1 is an MBMS sub-frame. In the MBMS sub-frame, a cell-specific pilot signal is multiplexed only in the four sub-carriers at the center of the beginning of the sub-frame.

[0087] The phase control unit 5 advances the 19th phase of sub-frame #0 by 4, and decides the phase of the first cell-specific pilot signal as 23 in the sub-frame #1. Then the phase control unit 5 advances the 26th phase of the sub-frame #1 by 14, and decides the phase of the first cell-specific pilot signal as 40 in the sub-frame #2. By this, the phases of the cell-specific pilot signals can be continuous in the sub-frames #0, #1 and #2.

[0088] Fig. 11 is another example of a radio frame according to the third embodiment. The phase of the first cell-specific pilot signal of the sub-frame #1 is decided as 20, so as to be continuous with the phases of the cell-specific pilot signals in the sub-frame #0. In order to make the sub-frame #1 continue to #2, the phase is controlled so that the 23rd phase of the cell-specific pilot signals of the sub-frame #1 is advanced by 17.

[0089] (Addition 1) A cell-specific pilot signal transmitting method used in a mobile communication system, which has a base station and a mobile station that performs radio communication with the base station in a cell of a radio communication area formed by the base station, and which mixes and transmits unicast data and broadcast/multicast data as downstream data from the base station to the mobile station, the method comprising:

by the base station,

setting a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station has transmitted the unicast data and a start phase of a cell-specific pilot signal transmitted in a next sub-frame to be equal to a difference between a start phase of a cell-specific pilot signal transmitted in a sub-

frame in which the base station transmitted the broadcast/multicast data and a start phase of a cell-specific pilot signal transmitted in a next sub-frame.

[0090] (Addition 2) The cell-specific pilot signal transmission method according to addition 1, further comprising:

by the base station,

setting a transmission start position in a next sub-frame of a cell-specific pilot signal to be transmitted in the next sub-frame of a sub-frame, in which the base station has transmitted the unicast data, to be equal to a transmission start position in a next sub-frame of a cell-specific pilot signal to be transmitted in the next sub-frame of a sub-frame in which the base station has transmitted the broadcast/multicast data.

[0091] (Addition 3) A pilot signal transmitting method in a mobile communication system that has a base station and a mobile station that performs radio communication with the base station in a cell of a radio communication area formed by the base station, wherein

in the case when a difference between a transmission start phase of the pilot signal to be transmitted and a transmission end phase thereof is varied between a first unit transmission period and a second unit transmission period,

the base station controls the difference between the transmission start phase of the pilot signal in the first unit transmission period, and the transmission start phase of the pilot signal in the second unit transmission period is controlled to be a predetermined difference which is greater than the difference between the transmission start phase and the transmission end phase.

[0092] (Addition 4) A base station that forms a radio communication area for communicating with a mobile station in a mobile communication system that mixes and transmits unicast data and broadcast/multicast data, the base station comprising:

a phase control unit to control for setting a

difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station has transmitted the unicast data and a start phase of a cell-specific pilot signal to be transmitted in a next sub-frame to be equal to a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station has transmitted the broadcast/multicast data and a start phase of a cell-specific pilot signal to be transmitted in the next sub-frame.

[0093] (Addition 5) A mobile station that forms a radio communication area with a base station in a mobile communication system that mixes and transmits unicast data and broadcast/multicast data, the mobile station comprising:

a receive unit to receive a cell-specific pilot signal controlled by the base station so that a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station transmitted the unicast data and a start phase of a cell-specific pilot signal to be transmitted in a next sub-frame and a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station transmitted the broadcast/multicast data and a start phase of a cell-specific pilot signal to be transmitted in a next sub-frame are a same predetermined amount; and

a phase control unit to control a phase of the received cell-specific pilot signal to be used for calculating correlation with the cell-specific pilot signal based on the phase calculated according to a position of the received sub-frame in a radio frame.

[0094] (Addition 6) A mobile communication system that has a base station and a mobile station that performs radio communication with the base station in a cell of a radio communication area formed by the base station, and that mixes and transmits unicast data and broadcast/multicast data as downstream data from the base station to the mobile station, wherein

the base station comprises:

a phase control unit to control for setting a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station transmitted the unicast data and a start phase of a cell-specific pilot signal to be transmitted in a next sub-frame to be equal to a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station transmitted the broadcast/multicast data and a start phase of a cell-specific pilot signal to be transmitted in a next sub-frame, and wherein

the mobile station comprises:

a phase control unit to control a phase of a cell-specific pilot signal to be used for calculating correlation with a received cell-specific pilot signal based on the phase calculated according to a position of a received sub-frame in a radio frame.

[0095] (Addition 7) The mobile communication system according to addition 6, wherein in the sub-frame, different numbers of sub-carriers are multiplexed using any of a plurality of frequency bands, and the phase control unit in the base station controls the phase so that a band corresponding to a synchronization channel in the narrowest frequency band, out of the plurality of frequency bands, matches the center of each of the plurality of frequency bands.

[0096] (Addition 8) The mobile communication system according to addition 6, wherein a cell-specific pilot signal in a sub-frame to which the broadcast/multicast data is allocated is transmitted only in a limited part of the bands, and the phase control unit is constructed so as to advance a phase of a cell-specific pilot signal in the next sub-frame by the amount of phase shift from the limited part of the bands.

53571-2

EXPLANATION OF REFERENCES

[0097]

1 DATA SELECTION UNIT

2 CELL-SPECIFIC PILOT CHANNEL SEQUENCE STORAGE UNIT

3 CELL-COMMON PILOT CHANNEL SEQUENCE STORAGE UNIT

4 PILOT SELECTION UNIT

5 PHASE CONTROL UNIT

6 PRIMARY SYNCHRONIZATION CHANNEL STORAGE UNIT

7 SECONDARY SYNCHRONIZATION CHANNEL STORAGE UNIT

8 CHANNEL MULTIPLEXING UNIT

9 SERIAL/PARALLEL CONVERSION PROCESSING UNIT

10 IFFT PROCESSING UNIT

11 GUARD INTERVAL INSERTION UNIT

12 RADIO PROCESSING UNIT

13 TRANSMISSION ANTENNA

20 RECEIVE ANTENNA UNIT

21 RADIO PROCESSING UNIT

22 GUARD INTERVAL REMOVAL UNIT

23 FFT PROCESSING UNIT

200 FIRST STEP PROCESSING UNIT

210 SECOND STEP PROCESSING UNIT

220 THIRD STEP PROCESSING UNIT

What is claimed is:

1. A cell-specific pilot signal transmitting method used in a mobile communication system, which has a base station and a mobile station that performs radio communication with the base station in a cell of a radio communication area formed by the base station, and which mixes and transmits unicast data and broadcast/multicast data as downstream data from the base station to the mobile station, the method comprising:

by the base station,

setting a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station has transmitted the unicast data and a start phase of a cell-specific pilot signal transmitted in a next sub-frame to be equal to a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station transmitted the broadcast/multicast data and a start phase of a cell-specific pilot signal transmitted in a next sub-frame.

2. The cell-specific pilot signal transmission method according to claim 1, further comprising:

by the base station,

setting a transmission start position in a next sub-frame of a cell-specific pilot signal to be transmitted in the next sub-frame of a sub-frame, in which the base station has transmitted the unicast data, to be equal to a transmission start position in a next sub-frame of a cell-specific pilot signal to be transmitted in the next sub-frame of a sub-frame in which the base station has transmitted the broadcast/multicast data.

3. A base station that forms a radio communication area for communicating with a mobile station in a mobile communication system that mixes and transmits unicast data and broadcast/multicast data, the base station comprising:

a phase control unit to control for setting a

difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station has transmitted the unicast data and a start phase of a cell-specific pilot signal to be transmitted in a next sub-frame to be equal to a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station has transmitted the broadcast/multicast data and a start phase of a cell-specific pilot signal to be transmitted in the next sub-frame.

4. A mobile station that communicates with a base station in a mobile communication system transmitting unicast data and broadcast/multicast data, the mobile station comprising:

a receive unit to receive a cell-specific pilot signal controlled by the base station so that a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station transmitted the unicast data and a start phase of a cell-specific pilot signal to be transmitted in a next sub-frame and a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station transmitted the broadcast/multicast data and a start phase of a cell-specific pilot signal to be transmitted in a next sub-frame are a same predetermined amount.

5. A mobile communication system including a base station and a mobile station in which the base station, transmits unicast data and broadcast/multicast data to the mobile station, wherein the base station comprises:

a phase control unit to control for setting a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station transmitted the unicast data and a start phase of a cell-specific pilot signal to be transmitted in a next sub-frame to be equal to a difference between a start phase of a cell-specific pilot signal transmitted in a sub-frame in which the base station transmitted the broadcast/multicast data and a start phase of a cell-specific pilot signal to be transmitted in a next sub-frame, and wherein the mobile station comprises:

a receive unit to receive the cell-specific pilot signal transmitted from the base station.

6. The mobile communication system according to Claim 5, wherein in the sub-frame, different numbers of sub-carriers are multiplexed using any of a plurality of frequency bands, and the phase control unit in the base station controls the phase so that a band corresponding to a synchronization channel in the narrowest frequency band, out of the plurality of frequency bands, matches the center of each of the plurality of frequency bands.

7. The mobile communication system according to Claim 5, wherein a cell-specific pilot signal in a sub-frame to which the broadcast/multicast data is allocated is transmitted only in a limited part of the bands, and the phase control unit is constructed so as to advance a phase of a cell-specific pilot signal in the next sub-frame by the amount of phase shift from the limited part of the bands.

8. A pilot signal transmitting method in a mobile communication system that has a base station and a mobile station that performs radio communication with the base station in a cell of a radio communication area formed by the base station, wherein

in the case when a difference between a transmission start phase of the pilot signal to be transmitted and a transmission end phase thereof is varied between a first unit transmission period and a second unit transmission period,

the base station controls the difference between the transmission start phase of the pilot signal in the first unit transmission period, and the transmission start phase of the pilot signal in the second unit transmission period is controlled to be a predetermined difference which is greater than the difference between the transmission start phase and the transmission end phase.

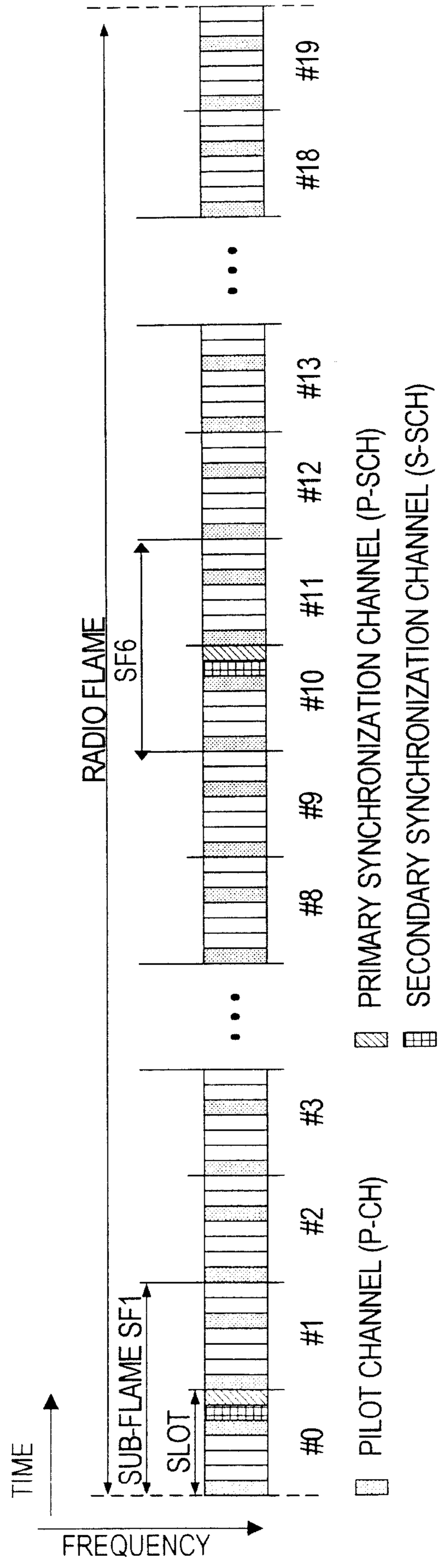


FIG. 1
(Prior Art)

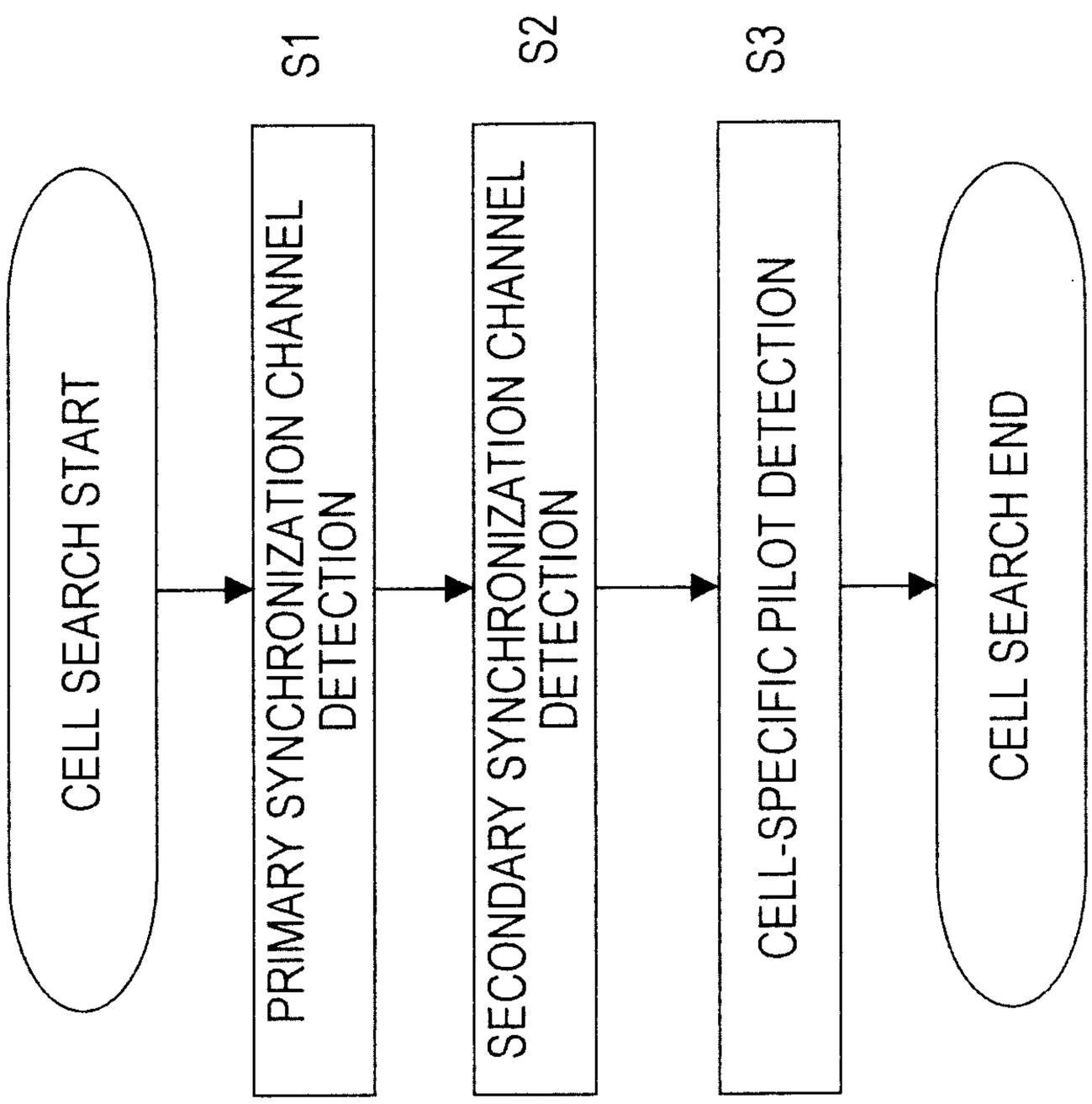


FIG. 2
(Prior Art)

FIG. 3
(Prior Art)

SUB-FRAME	SLOT NO.	PILOT NO. IN SLOT	CASE 1		CASE 2	
			SUB-FRAME	PHASE OF CELL-SPECIFIC SCRAMBLE CODE	SUB-FRAME	PHASE OF CELL-SPECIFIC SCRAMBLE CODE
0	0	1	UNICAST	0	UNICAST	0
		2		Np		Np
	1	1		2Np		2Np
		2		3Np		3Np
1	2	1	UNICAST	4Np	MBMS	4Np
		2		5Np		
	3	1		6Np		
		2		7Np		
2	4	1	UNICAST	8Np	UNICAST	5Np
		2		9Np		6Np
	5	1		10Np		7Np
		2		11Np		8Np
3	6	1	UNICAST	12Np	UNICAST	9Np
		2		13Np		10Np
	7	1		14Np		11Np
		2		15Np		12Np
4	8	1	UNICAST	16Np	MBMS	13Np
		2		17Np		
	9	1		18Np		
		2		19Np		
5	10	1	UNICAST	20Np	UNICAST	14Np
		2		21Np		15Np
	11	1		22Np		16Np
		2		23Np		17Np
6	12	1	UNICAST	24Np	UNICAST	18Np
		2		25Np		19Np
	13	1		26Np		20Np
		2		27Np		21Np
7	14	1	UNICAST	28Np	UNICAST	22Np
		2		29Np		23Np
	15	1		30Np		24Np
		2		31Np		25Np
8	16	1	UNICAST	32Np	UNICAST	26Np
		2		33Np		27Np
	17	1		34Np		28Np
		2		35Np		29Np
9	18	1	UNICAST	36Np	UNICAST	30Np
		2		37Np		31Np
	19	1		38Np		32Np
		2		39Np		33Np

CA 02681590 2012-11-08

FIG. 4

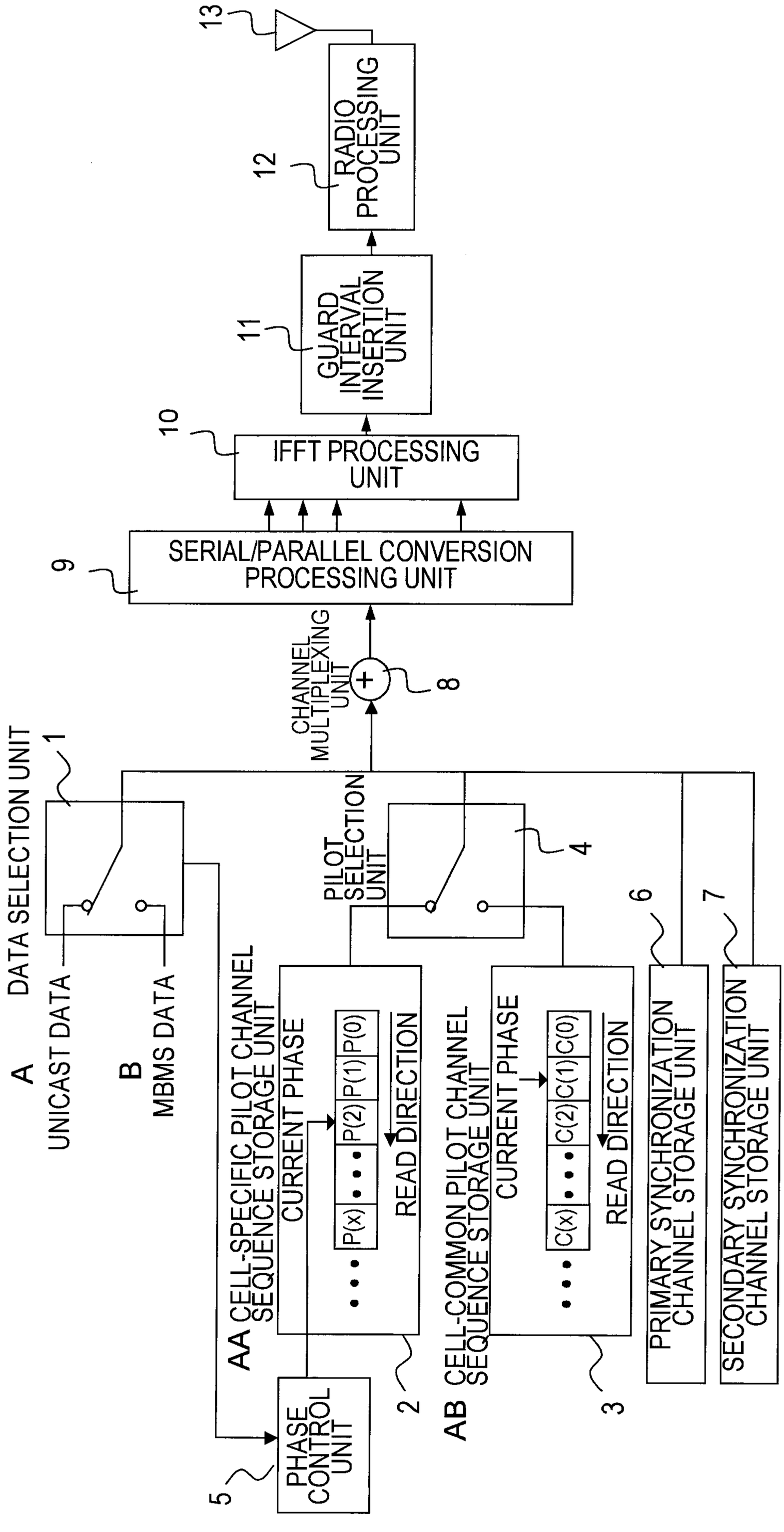
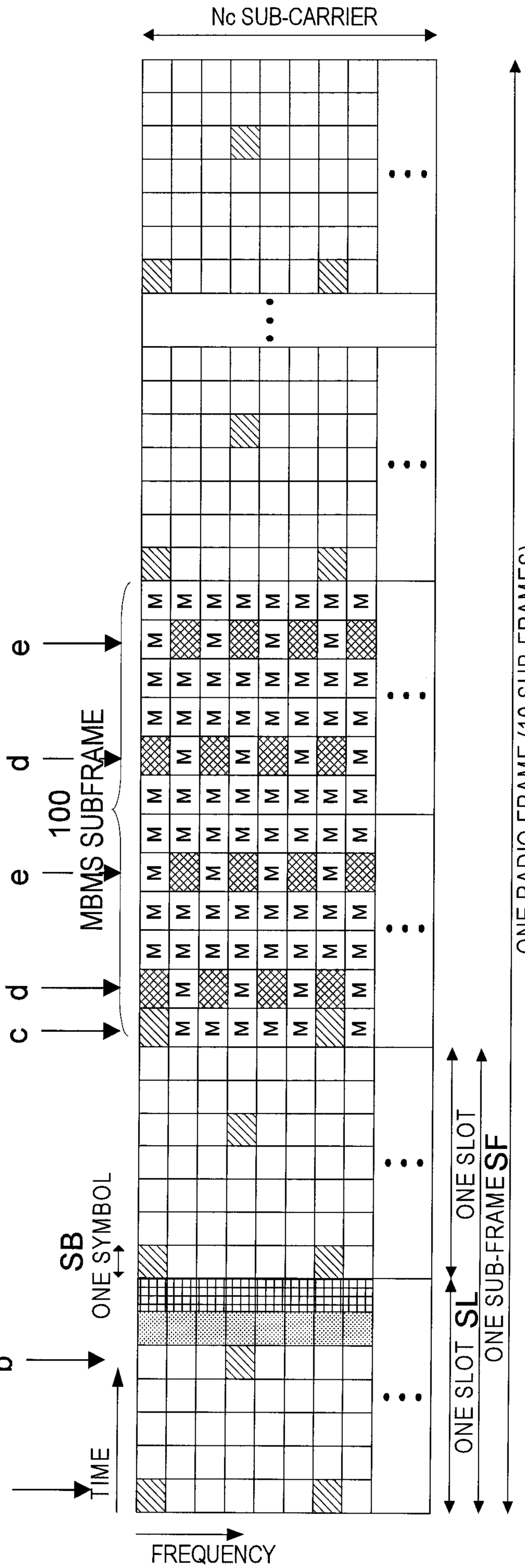

13
RADIO PROCESSING UNIT
12
GUARD INTERVAL INSERTION UNIT
11
IFFT PROCESSING UNIT
10
SERIAL/PARALLEL CONVERSION PROCESSING UNIT
9
CHANNEL MULTIPLEXING UNIT
8
DATA SELECTION UNIT
1
A
UNICAST DATA
B
MBMS DATA
PILOT SELECTION UNIT
4
6
7
AA CELL-SPECIFIC PILOT CHANNEL SEQUENCE STORAGE UNIT
CURRENT PHASE
P(x) • • • P(2) P(1) P(0)
READ DIRECTION
AB CELL-COMMON PILOT CHANNEL SEQUENCE STORAGE UNIT
CURRENT PHASE
C(x) • • • C(2) C(1) C(0)
READ DIRECTION
PRIMARY SYNCHRONIZATION CHANNEL STORAGE UNIT
SECONDARY SYNCHRONIZATION CHANNEL STORAGE UNIT
PHASE CONTROL UNIT
5
2
3

FIG. 5


Nc SUB-CARRIER
a
b
c
d
e
100
MBMS SUBFRAME
SB
ONE SYMBOL
TIME
FREQUENCY
ONE SLOT SL
ONE SUB-FRAME SF
ONE RADIO FRAME (10 SUB-FRAMES) RF
PRIMARY SYNCHRONIZATION CHANNEL(P-SCH)
SECONDARY SYNCHRONIZATION CHANNEL(S-SCH)
AA
CELL-SPECIFIC PILOT
AB
CELL-COMMON PILOT
UNICAST DATA
M
MBMS DATA

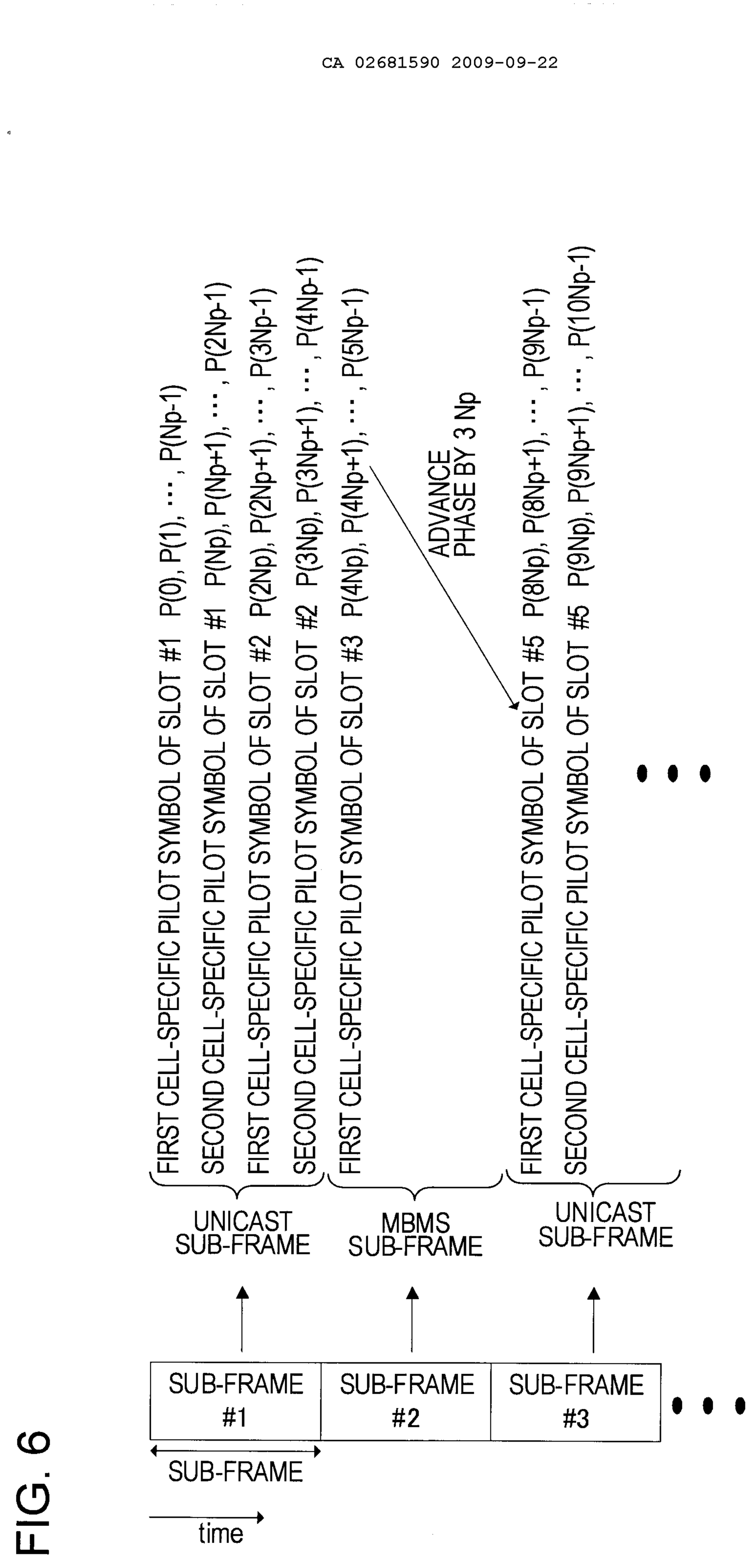
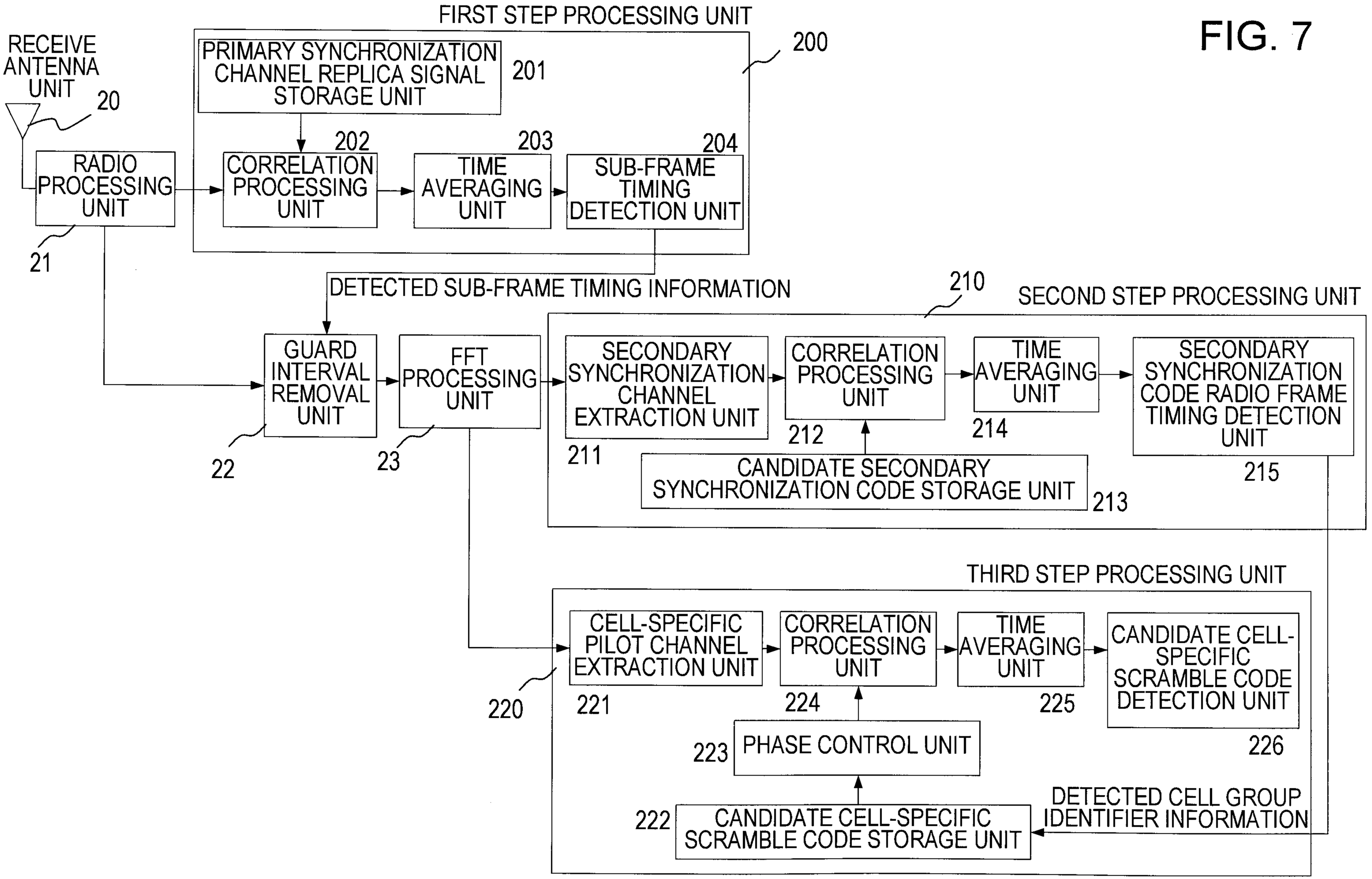

FIRST CELL-SPECIFIC PILOT SYMBOL OF SLOT #1 P(0), P(1), ···, P(Np-1)
SECOND CELL-SPECIFIC PILOT SYMBOL OF SLOT #1 P(Np), P(Np+1), ···, P(2Np-1)
FIRST CELL-SPECIFIC PILOT SYMBOL OF SLOT #2 P(2Np), P(2Np+1), ···, P(3Np-1)
SECOND CELL-SPECIFIC PILOT SYMBOL OF SLOT #2 P(3Np), P(3Np+1), ···, P(4Np-1)
FIRST CELL-SPECIFIC PILOT SYMBOL OF SLOT #3 P(4Np), P(4Np+1), ···, P(5Np-1)
ADVANCE PHASE BY 3 Np
FIRST CELL-SPECIFIC PILOT SYMBOL OF SLOT #5 P(8Np), P(8Np+1), ···, P(9Np-1)
SECOND CELL-SPECIFIC PILOT SYMBOL OF SLOT #5 P(9Np), P(9Np+1), ···, P(10Np-1)
UNICAST SUB-FRAME
MBMS SUB-FRAME
UNICAST SUB-FRAME
SUB-FRAME #1
SUB-FRAME #2
SUB-FRAME #3
SUB-FRAME
time

FIG. 6

FIG. 7



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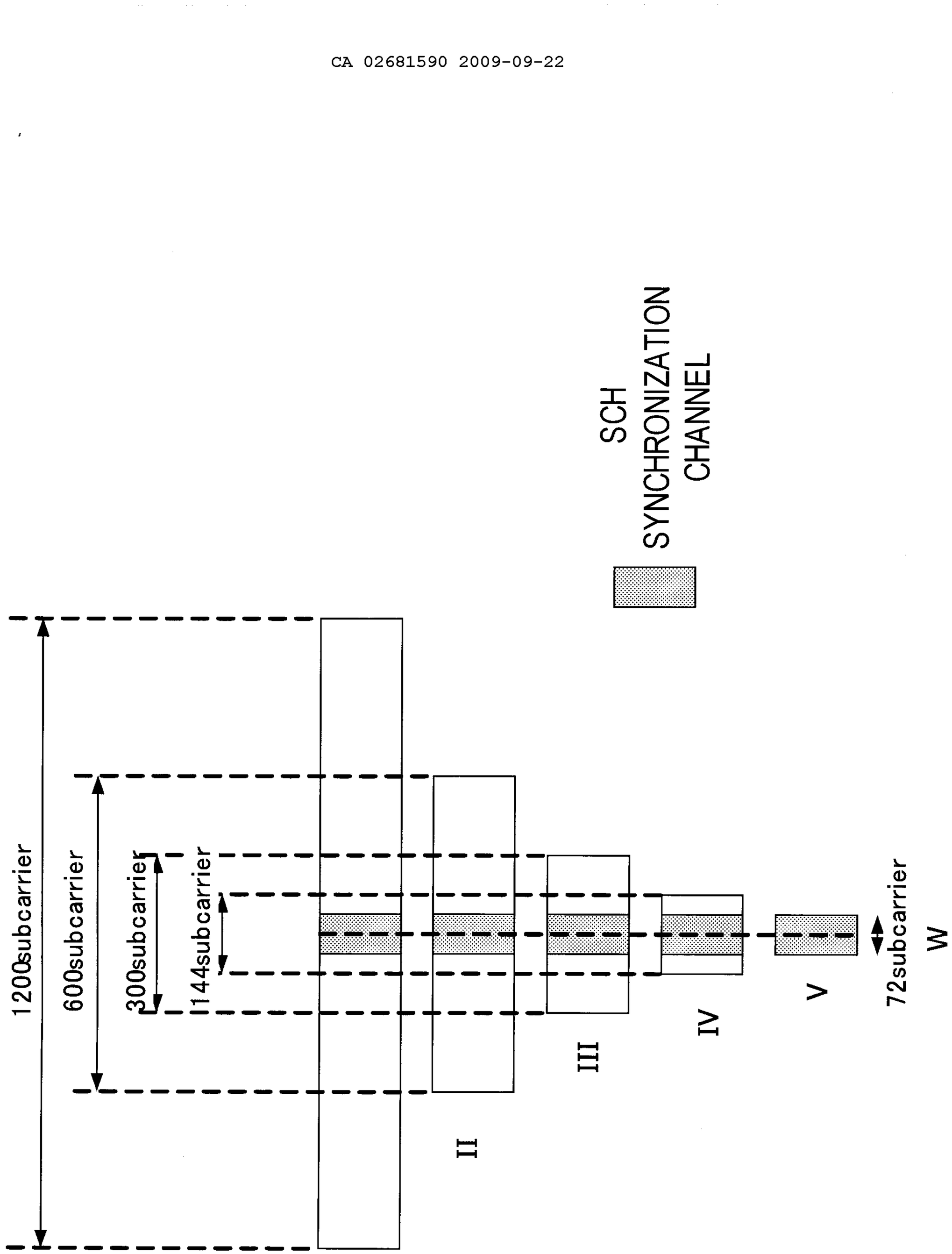
SCH
SYNCHRONI
CHANN
1200subcarrier
600subcarrier
300subcarrier
144subcarrier
72subcarrier
W
V
IV
III
II
I

FIG. 8

FIG. 9

SUB-FRAME NO.	SLOT NO.	PILOT NO. IN SLOT	1200 SUBCARRIER PHASE OF CELL-SPECIFIC SCRAMBLE CODE	600 SUBCARRIER PHASE OF CELL-SPECIFIC SCRAMBLE CODE	300 SUBCARRIER PHASE OF CELL-SPECIFIC SCRAMBLE CODE	144 SUBCARRIER PHASE OF CELL-SPECIFIC SCRAMBLE CODE	72 SUBCARRIER PHASE OF CELL-SPECIFIC SCRAMBLE CODE
0	0	1	0 ~ 199	50 ~ 149	75 ~ 124	88 ~ 111	94 ~ 105
		2	200 ~ 399	250 ~ 349	275 ~ 324	288 ~ 311	294 ~ 305
	1	1	400 ~ 599	450 ~ 549	475 ~ 524	488 ~ 511	494 ~ 505
		2	600 ~ 799	650 ~ 749	675 ~ 724	688 ~ 711	694 ~ 705
1	2	1	800 ~ 999	850 ~ 949	875 ~ 924	888 ~ 911	894 ~ 905
		2	1000 ~ 1199	1050 ~ 1149	1075 ~ 1124	1088 ~ 1111	1094 ~ 1105
	3	1	1200 ~ 1399	1250 ~ 1349	1275 ~ 1324	1288 ~ 1311	1294 ~ 1305
		2	1400 ~ 1599	1450 ~ 1549	1475 ~ 1524	1488 ~ 1511	1494 ~ 1505
2	4	1	1600 ~ 1799	1650 ~ 1749	1675 ~ 1724	1688 ~ 1711	1694 ~ 1705
		2	1800 ~ 1999	1850 ~ 1949	1875 ~ 1924	1888 ~ 1911	1894 ~ 1905
	5	1	2000 ~ 2199	2050 ~ 2149	2075 ~ 2124	2088 ~ 2111	2094 ~ 2105
		2	2200 ~ 2399	2250 ~ 2349	2275 ~ 2324	2288 ~ 2311	2294 ~ 2305
3	6	1	2400 ~ 2599	2450 ~ 2549	2475 ~ 2524	2488 ~ 2511	2494 ~ 2505
		2	2600 ~ 2799	2650 ~ 2749	2675 ~ 2724	2688 ~ 2711	2694 ~ 2705
	7	1	2800 ~ 2999	2850 ~ 2949	2875 ~ 2924	2888 ~ 2911	2894 ~ 2905
		2	3000 ~ 3199	3050 ~ 3149	3075 ~ 3124	3088 ~ 3111	3094 ~ 3105
4	8	1	3200 ~ 3399	3250 ~ 3349	3275 ~ 3324	3288 ~ 3311	3294 ~ 3305
		2	3400 ~ 3599	3450 ~ 3549	3475 ~ 3524	3488 ~ 3511	3494 ~ 3505
	9	1	3600 ~ 3799	3650 ~ 3749	3675 ~ 3724	3688 ~ 3711	3694 ~ 3705
		2	3800 ~ 3999	3850 ~ 3949	3875 ~ 3924	3888 ~ 3911	3894 ~ 3905
5	10	1	4000 ~ 4199	4050 ~ 4149	4075 ~ 4124	4088 ~ 4111	4094 ~ 4105
		2	4200 ~ 4399	4250 ~ 4349	4275 ~ 4324	4288 ~ 4311	4294 ~ 4305
	11	1	4400 ~ 4599	4450 ~ 4549	4475 ~ 4524	4488 ~ 4511	4494 ~ 4505
		2	4600 ~ 4799	4650 ~ 4749	4675 ~ 4724	4688 ~ 4711	4694 ~ 4705
6	12	1	4800 ~ 4999	4850 ~ 4949	4875 ~ 4924	4888 ~ 4911	4894 ~ 4905
		2	5000 ~ 5199	5050 ~ 5149	5075 ~ 5124	5088 ~ 5111	5094 ~ 5105
	13	1	5200 ~ 5399	5250 ~ 5349	5275 ~ 5324	5288 ~ 5311	5294 ~ 5305
		2	5400 ~ 5599	5450 ~ 5549	5475 ~ 5524	5488 ~ 5511	5494 ~ 5505
7	14	1	5600 ~ 5799	5650 ~ 5749	5675 ~ 5724	5688 ~ 5711	5694 ~ 5705
		2	5800 ~ 5999	5850 ~ 5949	5875 ~ 5924	5888 ~ 5911	5894 ~ 5905
	15	1	6000 ~ 6199	6050 ~ 6149	6075 ~ 6124	6088 ~ 6111	6094 ~ 6105
		2	6200 ~ 6399	6250 ~ 6349	6275 ~ 6324	6288 ~ 6311	6294 ~ 6305
8	16	1	6400 ~ 6599	6450 ~ 6549	6475 ~ 6524	6488 ~ 6511	6494 ~ 6505
		2	6600 ~ 6799	6650 ~ 6749	6675 ~ 6724	6688 ~ 6711	6694 ~ 6705
	17	1	6800 ~ 6999	6850 ~ 6949	6875 ~ 6924	6888 ~ 6911	6894 ~ 6905
		2	7000 ~ 7199	7050 ~ 7149	7075 ~ 7124	7088 ~ 7111	7094 ~ 7105
9	18	1	7200 ~ 7399	7250 ~ 7349	7275 ~ 7324	7288 ~ 7311	7294 ~ 7305
		2	7400 ~ 7599	7450 ~ 7549	7475 ~ 7524	7488 ~ 7511	7494 ~ 7505
	19	1	7600 ~ 7799	7650 ~ 7749	7675 ~ 7724	7688 ~ 7711	7694 ~ 7705
		2	7800 ~ 7999	7850 ~ 7949	7875 ~ 7924	7888 ~ 7911	7894 ~ 7905

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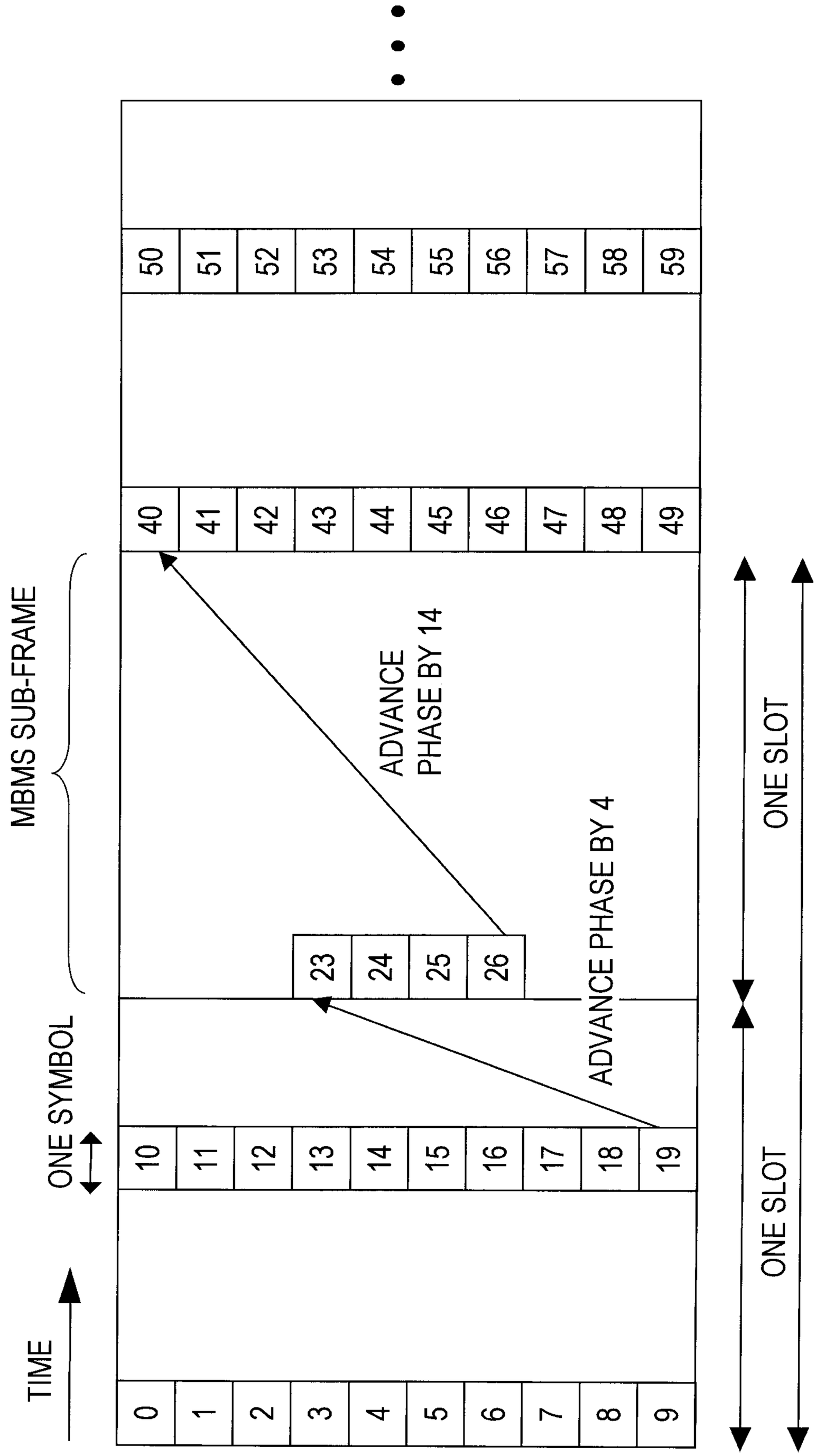
50
51
52
53
54
55
56
57
58
59
40
41
42
43
44
45
46
47
48
49
ADVANCE PHASE BY 14
23
24
25
26
ADVANCE PHASE BY 4
10
11
12
13
14
15
16
17
18
19
0
1
2
3
4
5
6
7
8
9
MBMS SUB-FRAME
ONE SYMBOL
ONE SLOT
ONE SUB-FRAME
TIME
FREQUENCY

FIG. 10

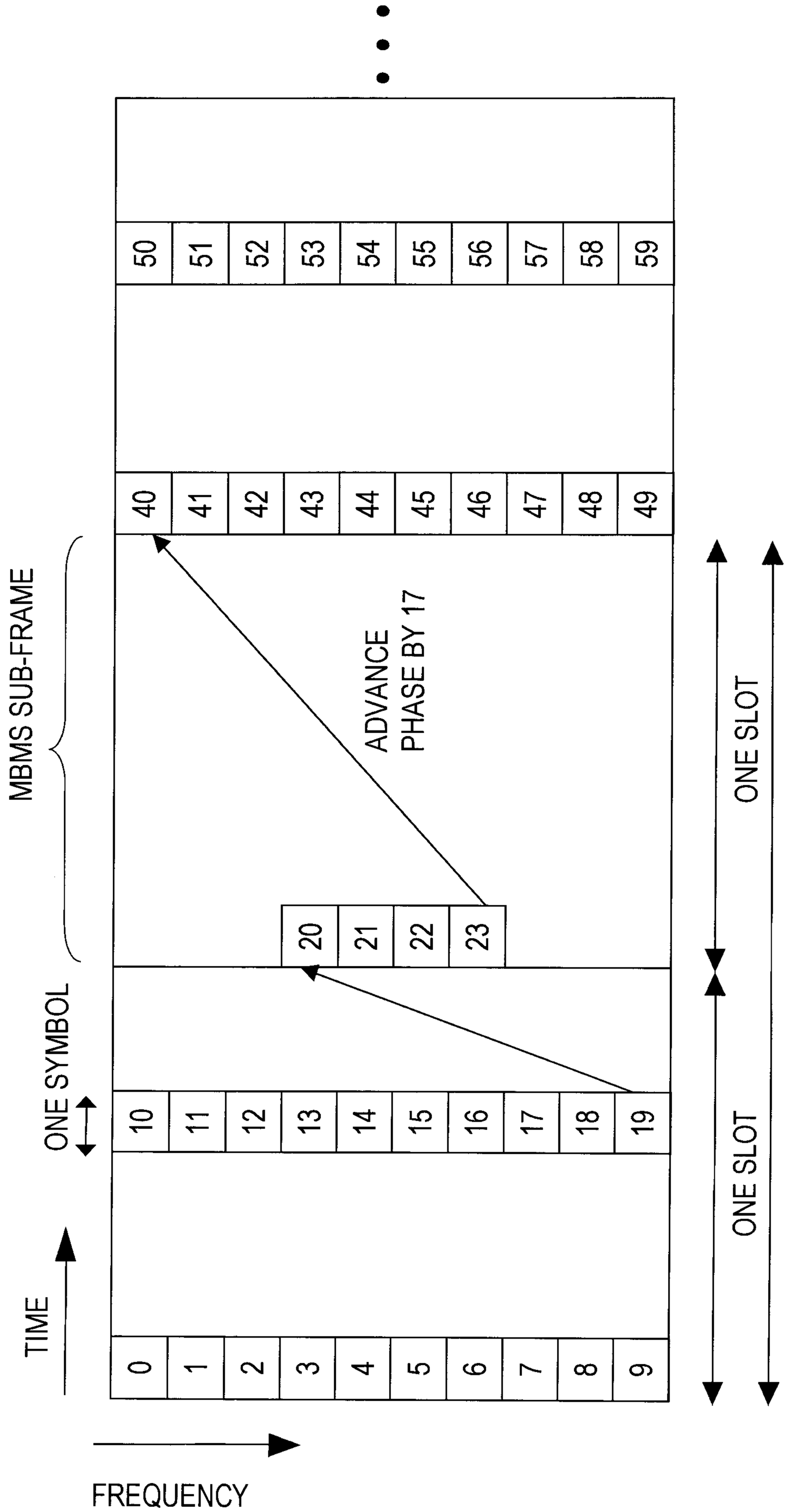
50
51
52
53
54
55
56
57
58
59
40
41
42
43
44
45
46
47
48
49
ADVANCE PHASE BY 17
20
21
22
23
10
11
12
13
14
15
16
17
18
19
0
1
2
3
4
5
6
7
8
9
MBMS SUB-FRAME
ONE SYMBOL
TIME
FREQUENCY
ONE SLOT
ONE SUB-FRAME

FIG. 11

time
SUB-FRAME
SUB-FRAME #1
SUB-FRAME #2
SUB-FRAME #3
UNICAST SUB-FRAME
MBMS SUB-FRAME
UNICAST SUB-FRAME
FIRST CELL-SPECIFIC PILOT SYMBOL OF SLOT #1 P(0), P(1), ⋯ , P(Np-1)
SECOND CELL-SPECIFIC PILOT SYMBOL OF SLOT #1 P(Np), P(Np+1), ⋯ , P(2Np-1)
FIRST CELL-SPECIFIC PILOT SYMBOL OF SLOT #2 P(2Np), P(2Np+1), ⋯ , P(3Np-1)
SECOND CELL-SPECIFIC PILOT SYMBOL OF SLOT #2 P(3Np), P(3Np+1), ⋯ , P(4Np-1)
FIRST CELL-SPECIFIC PILOT SYMBOL OF SLOT #3 P(4Np), P(4Np+1), ⋯ , P(5Np-1)
ADVANCE PHASE BY 3 Np
FIRST CELL-SPECIFIC PILOT SYMBOL OF SLOT #5 P(8Np), P(8Np+1), ⋯ , P(9Np-1)
SECOND CELL-SPECIFIC PILOT SYMBOL OF SLOT #5 P(9Np), P(9Np+1), ⋯ , P(10Np-1)