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(54) **METHOD AND APPARATUS FOR TRANSMITTING AND RECEIVING COMMON CHANNEL INFORMATION IN WIRELESS COMMUNICATION SYSTEM**

(52) **U.S. Cl.**  
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(57) **ABSTRACT**

Methods and apparatus are provided for transmission and reception of common channel information in a mobile communication system using multi-antenna-based beamforming. A number of beams to be used for transmission to a terminal is determined at a base station. The common channel information is generated corresponding to the number of beams. The common channel information is trans-

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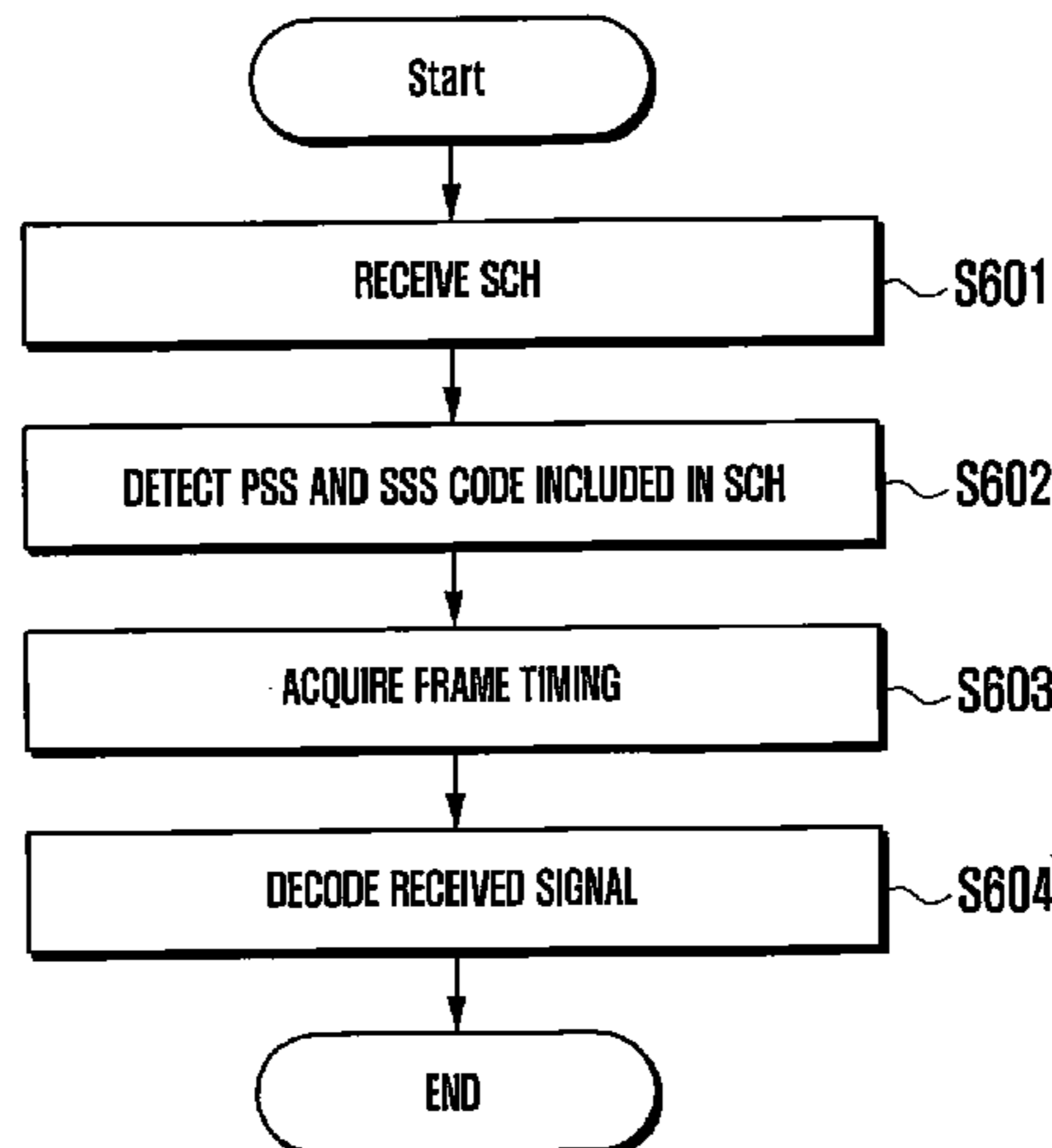
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FIG. 1

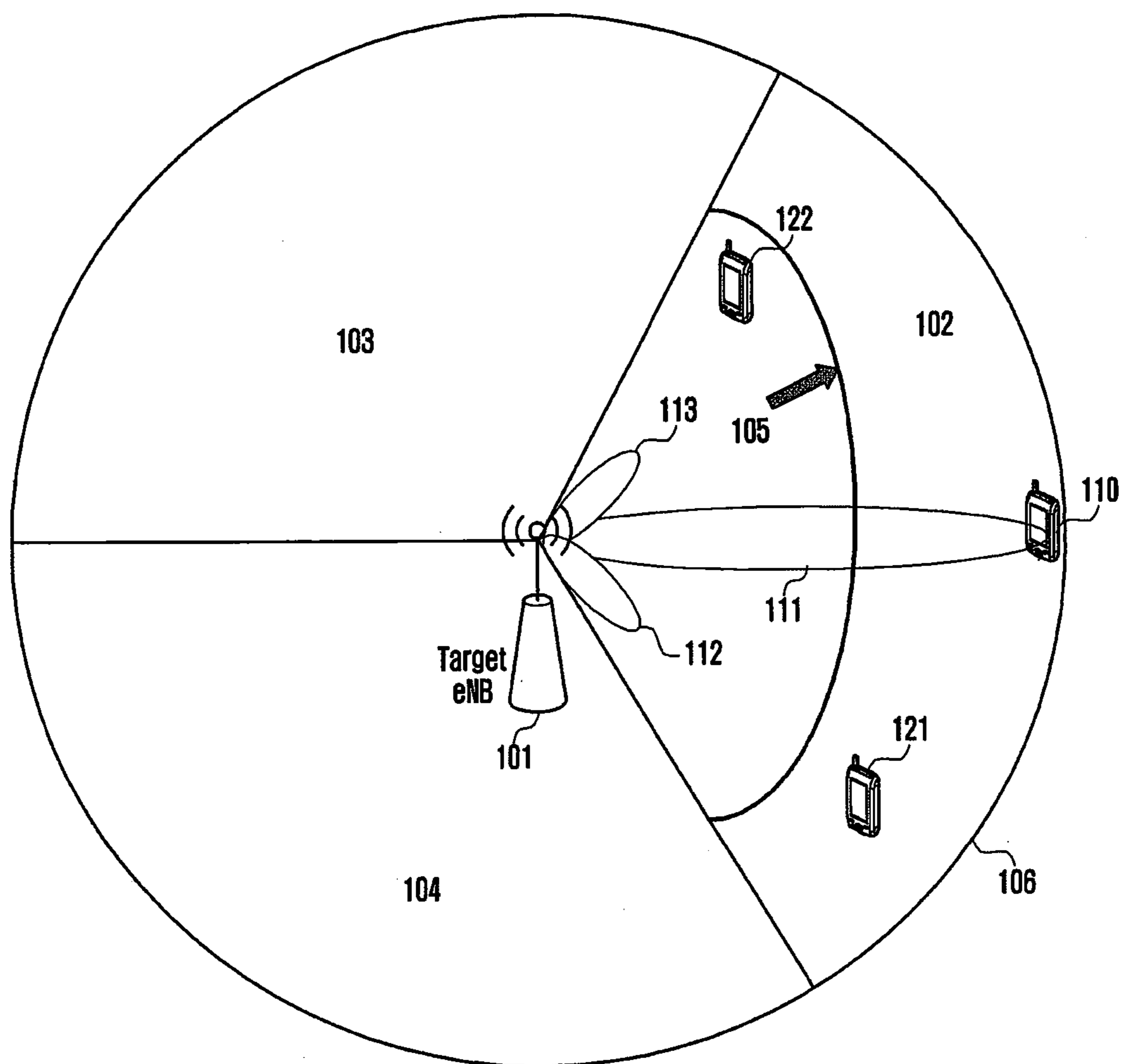


FIG. 2

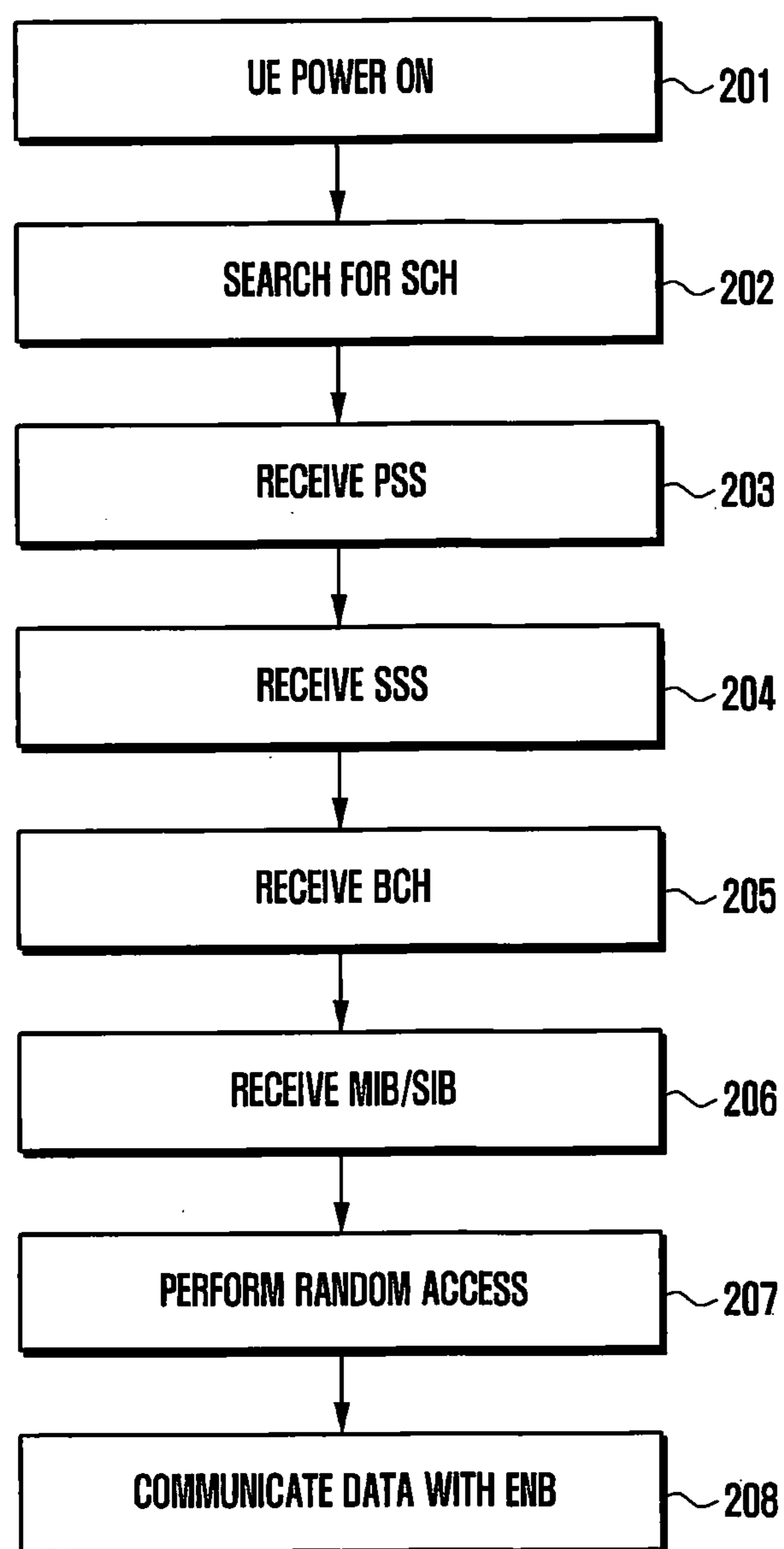


FIG. 3

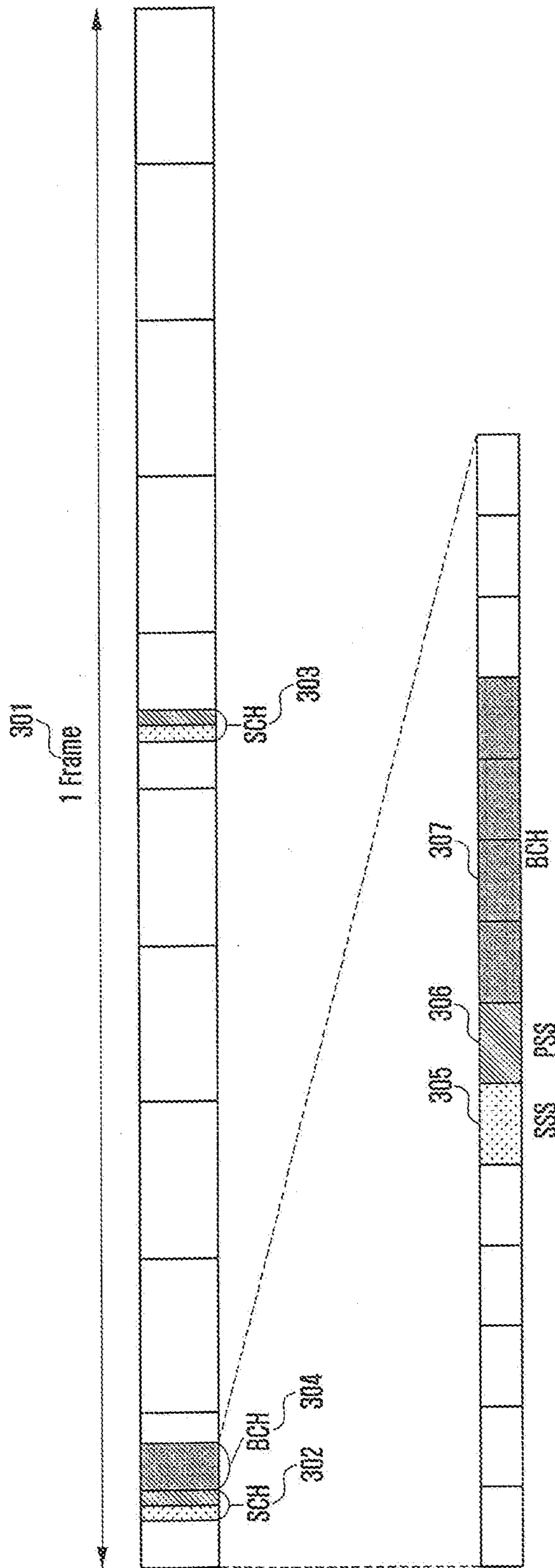


FIG. 4

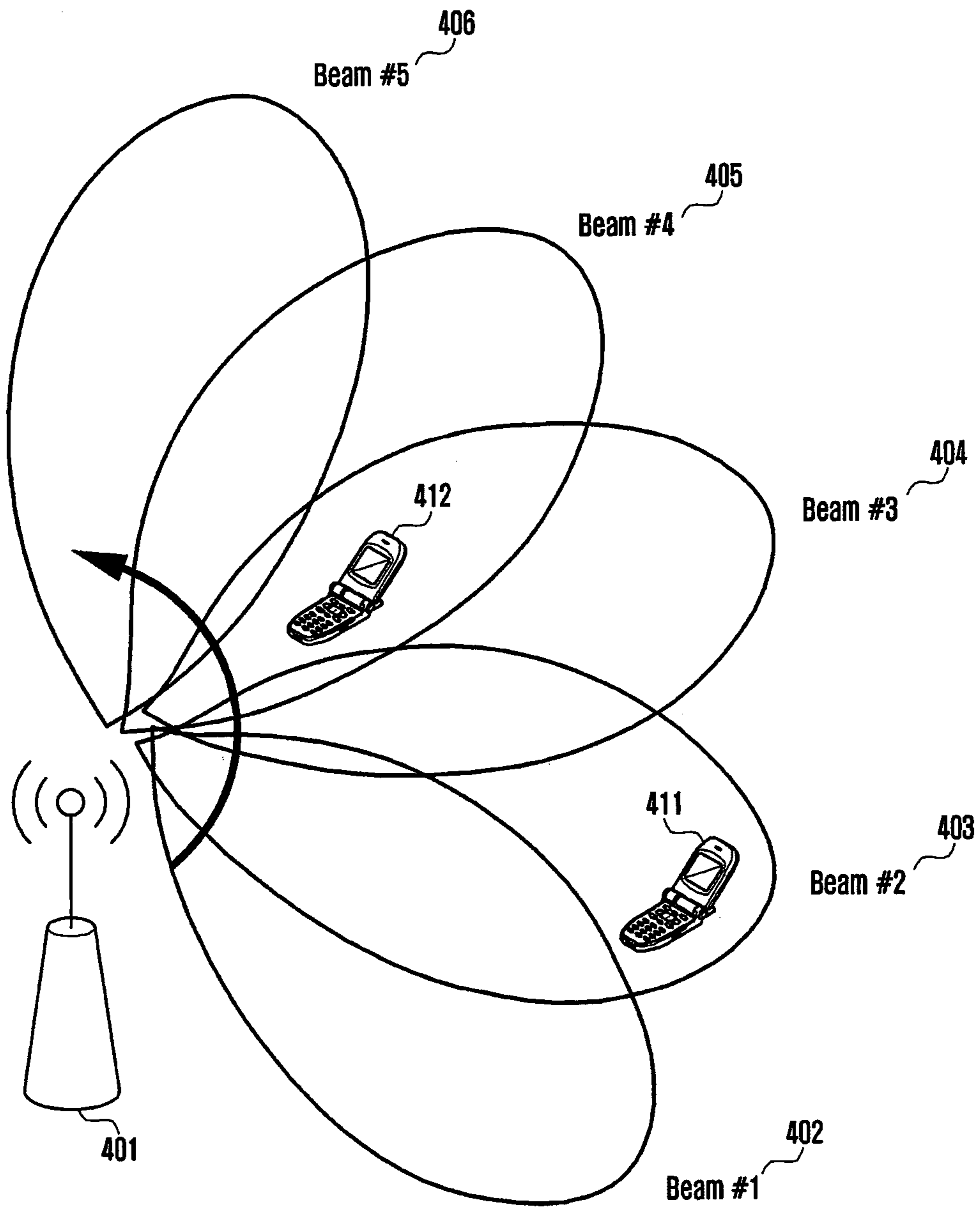


FIG. 5

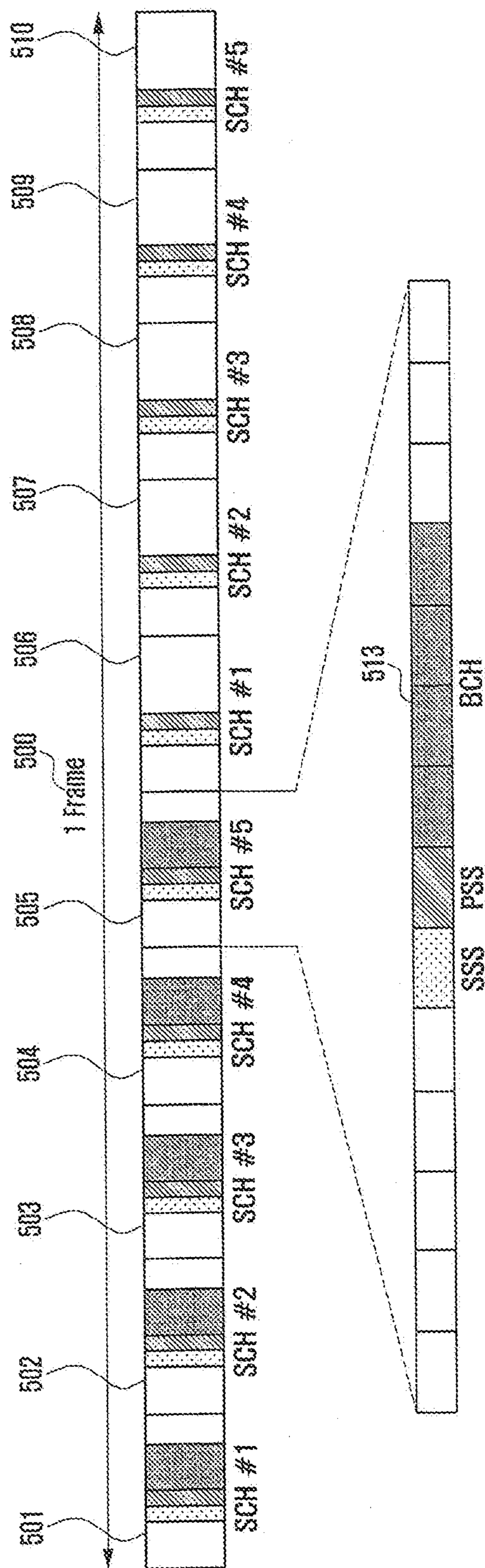




FIG. 6A

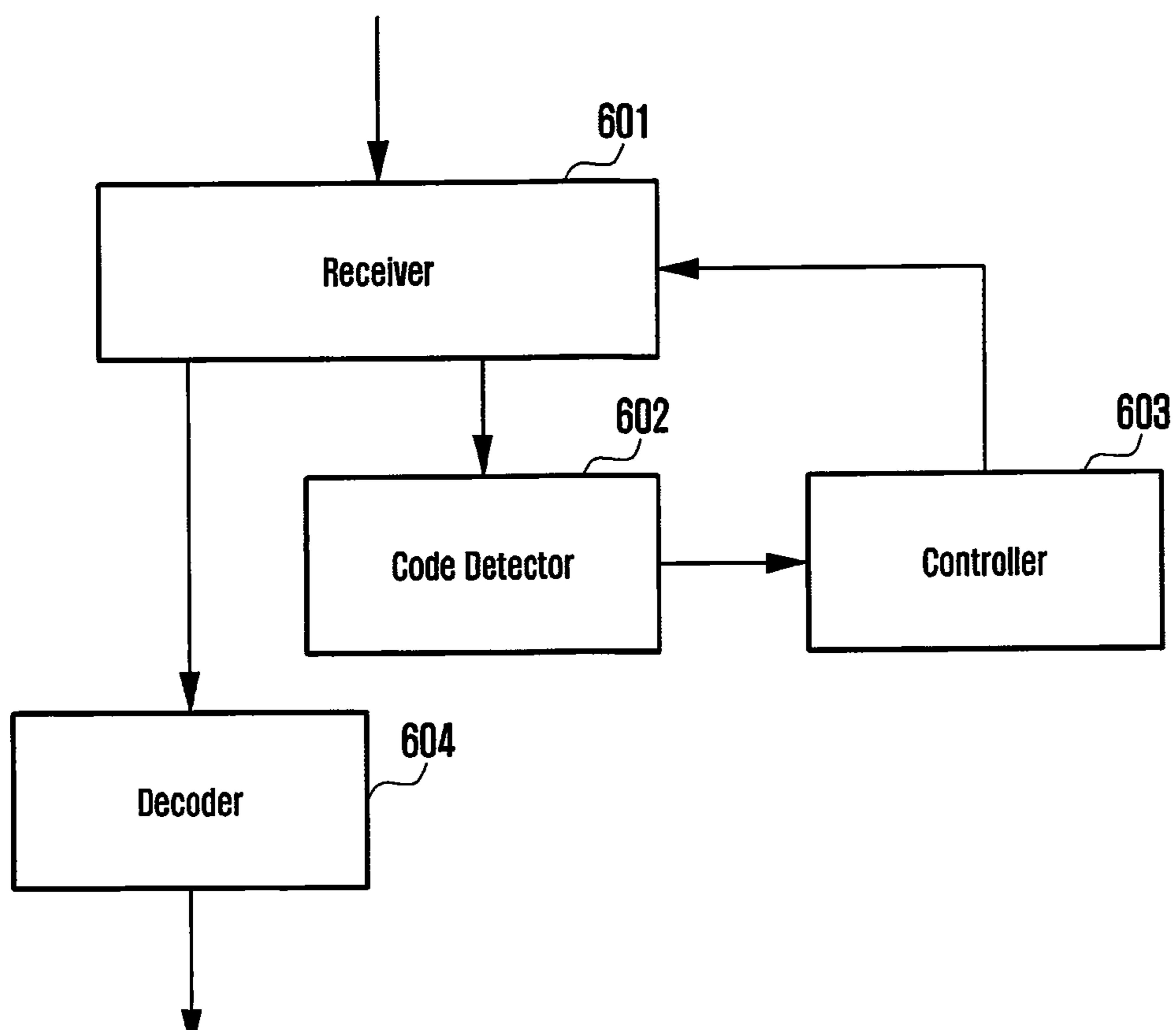


FIG. 6B

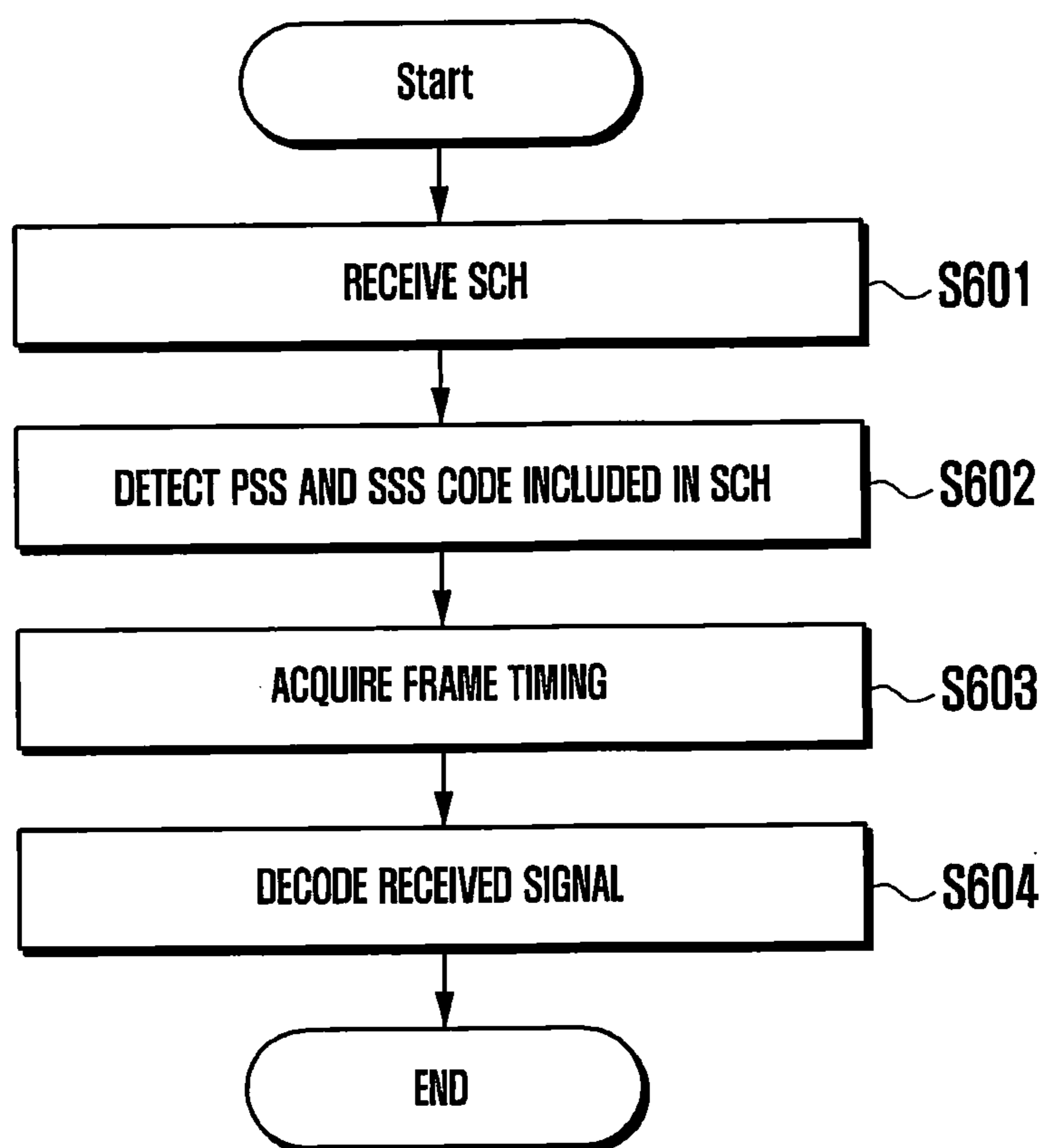


FIG. 7A

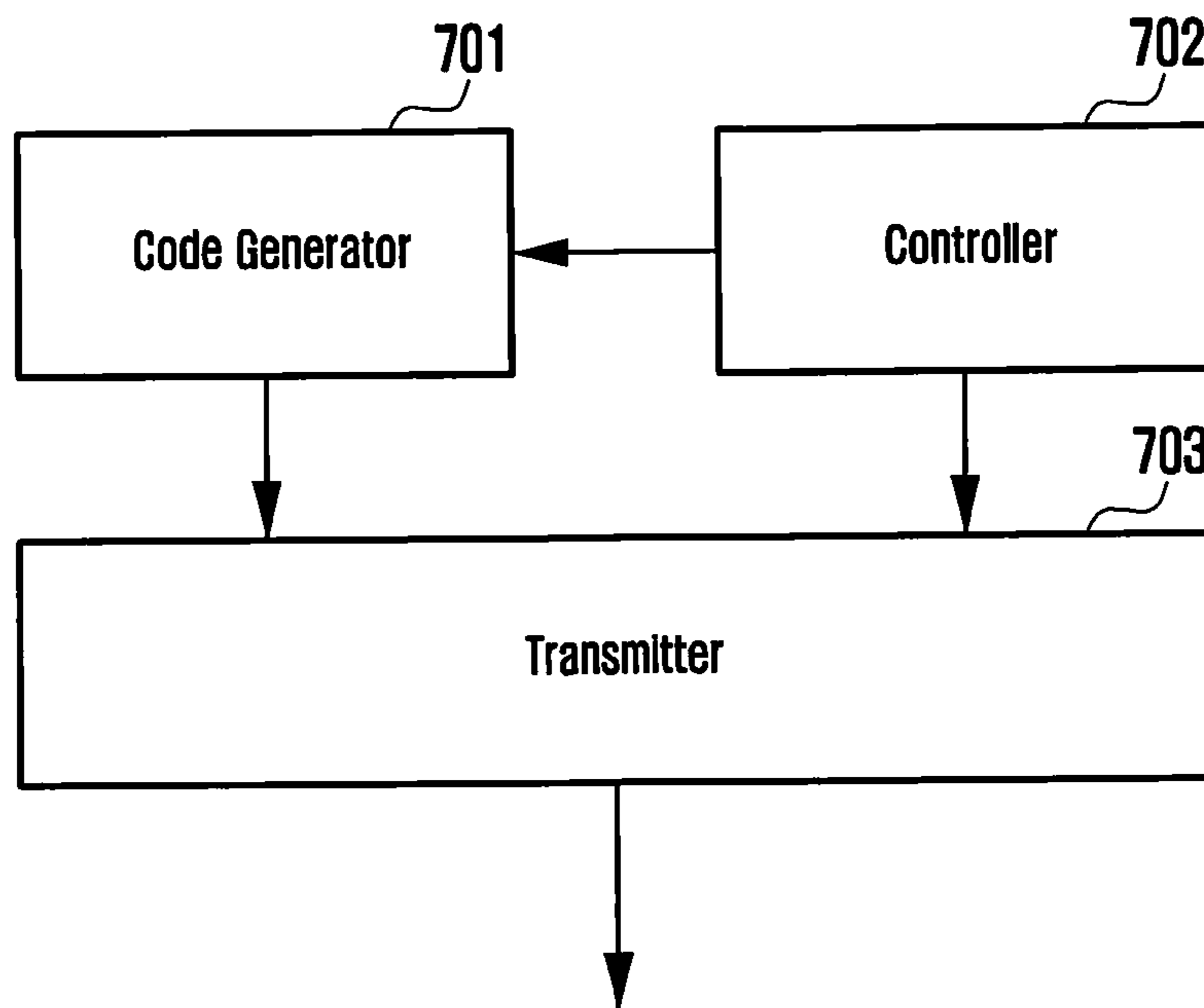


FIG. 7B

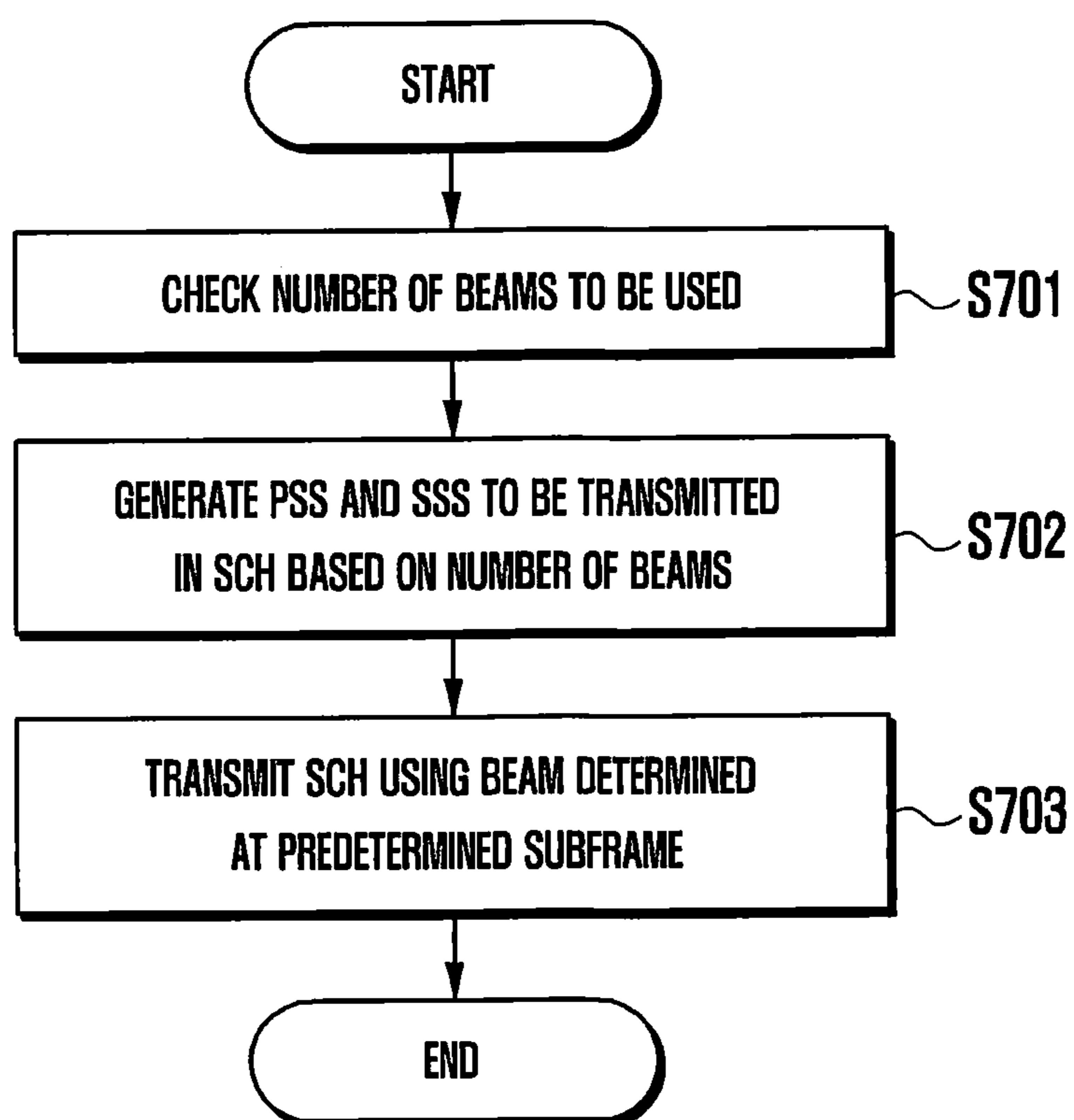


FIG. 8A

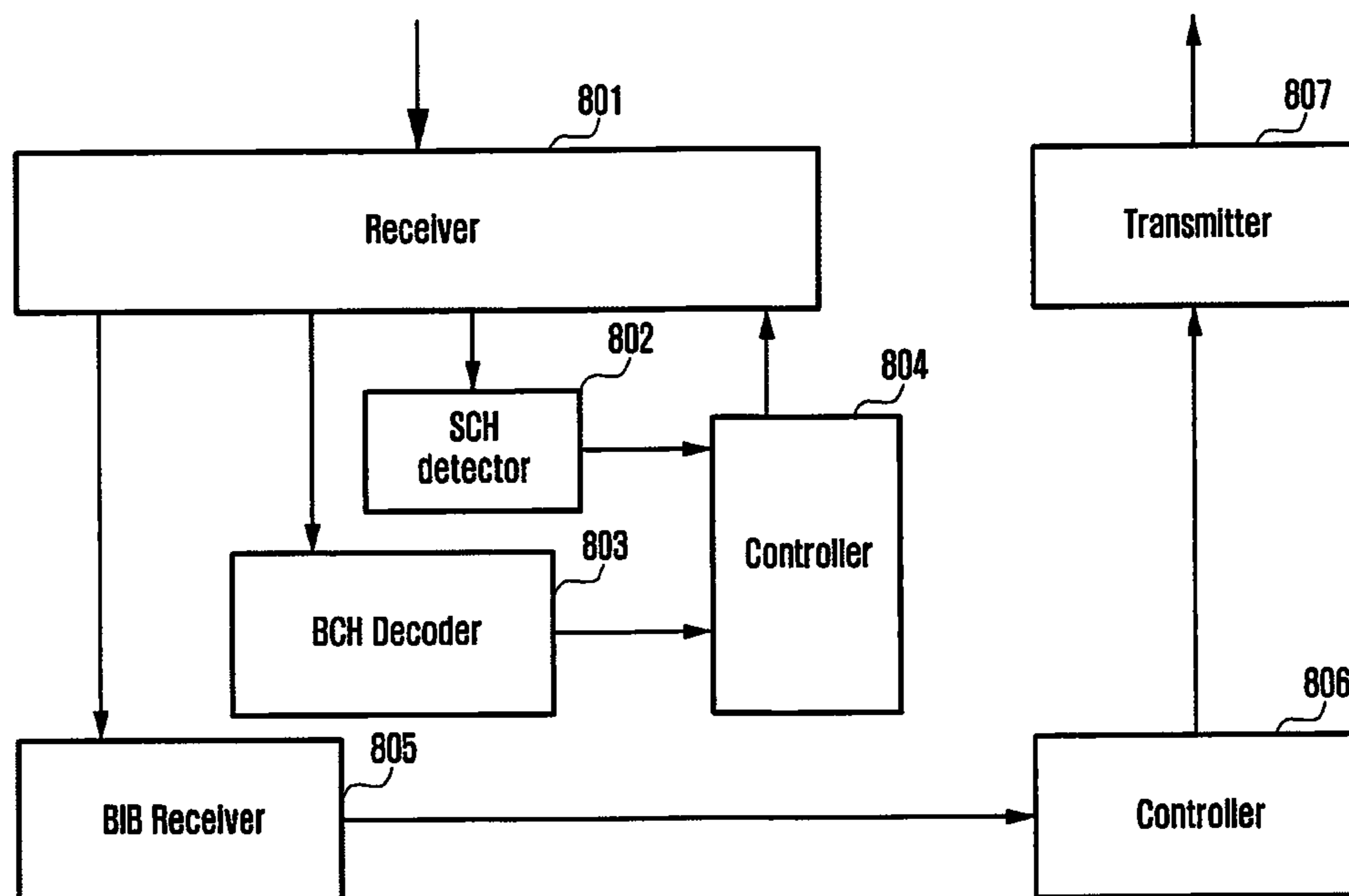


FIG. 8B

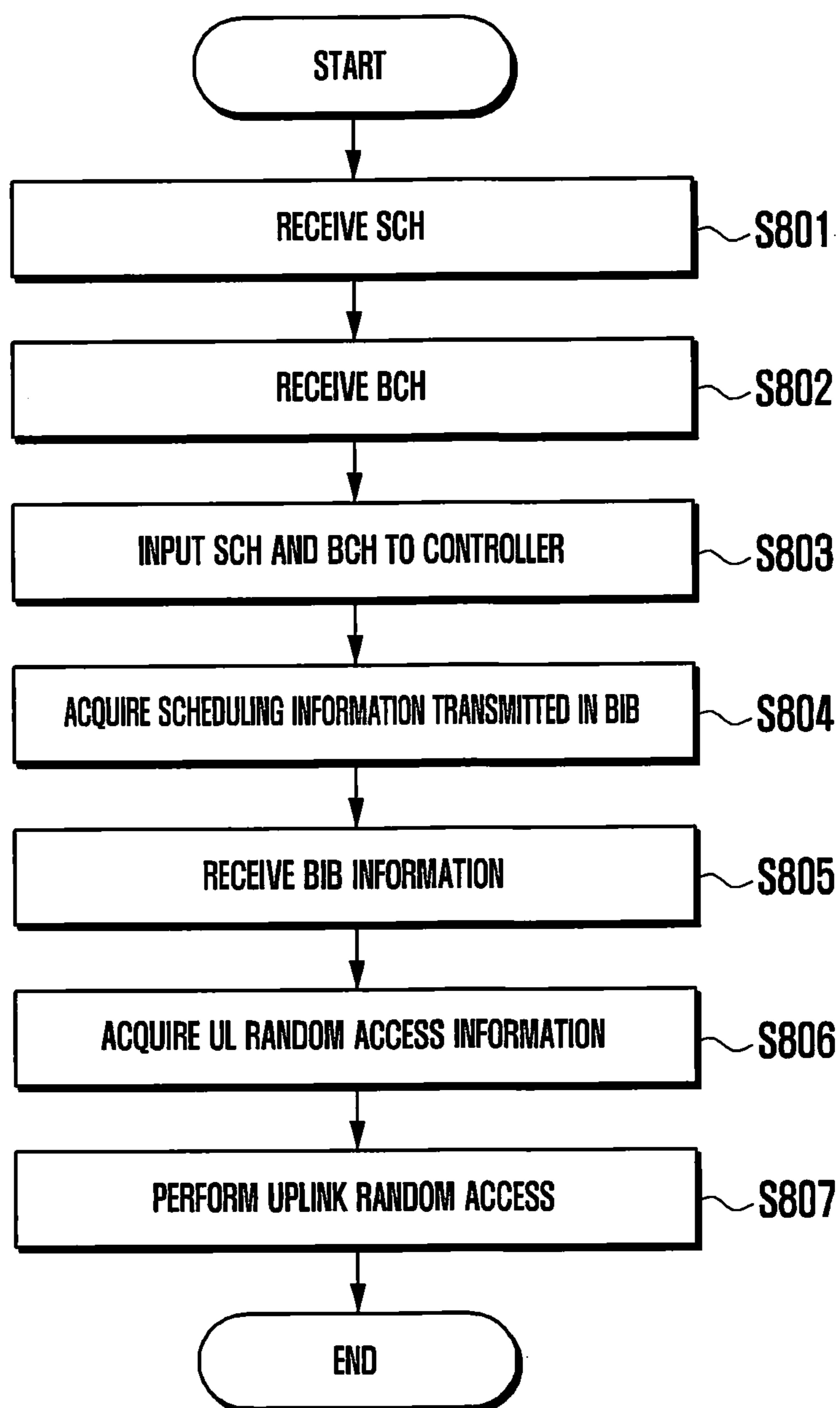


FIG. 9A

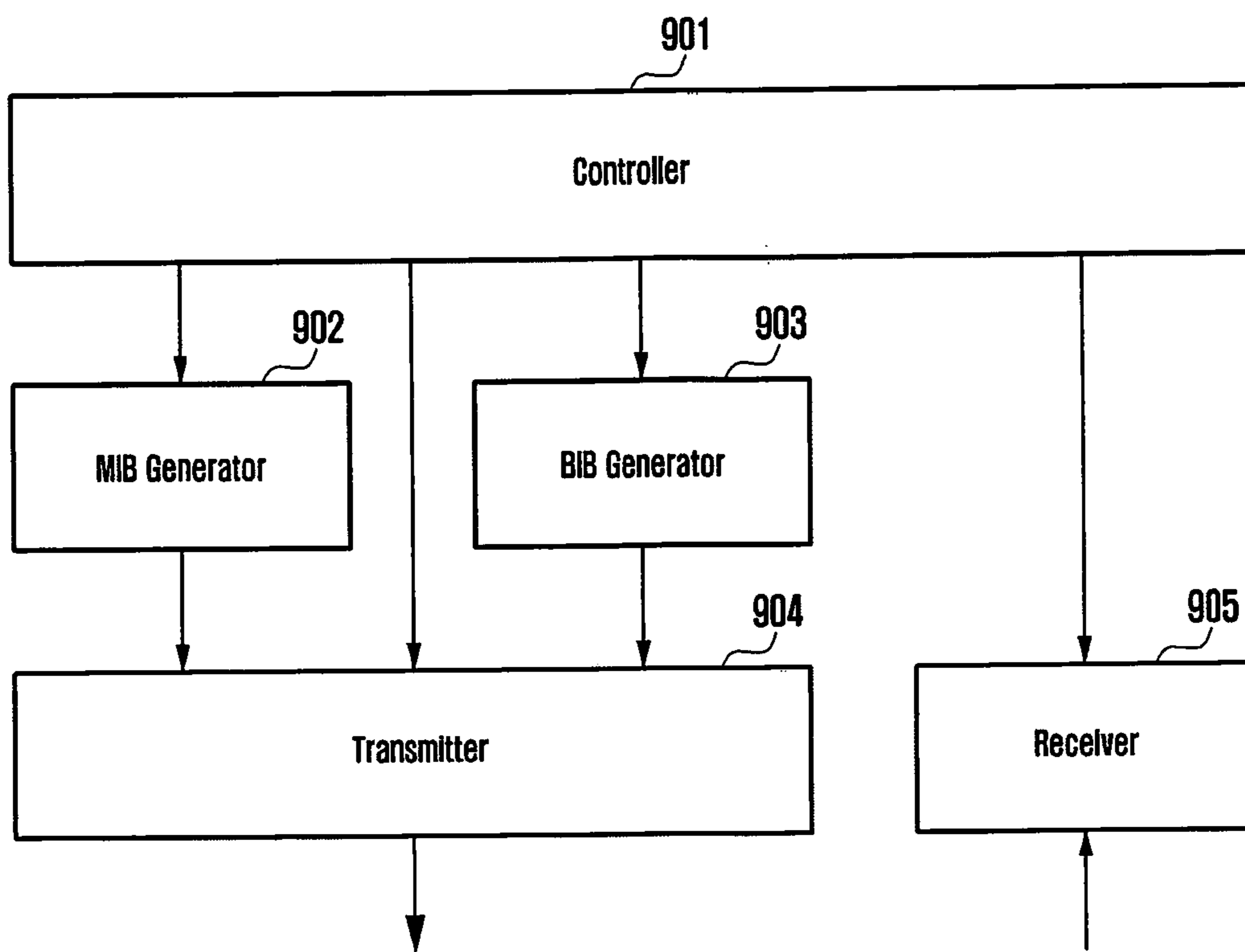
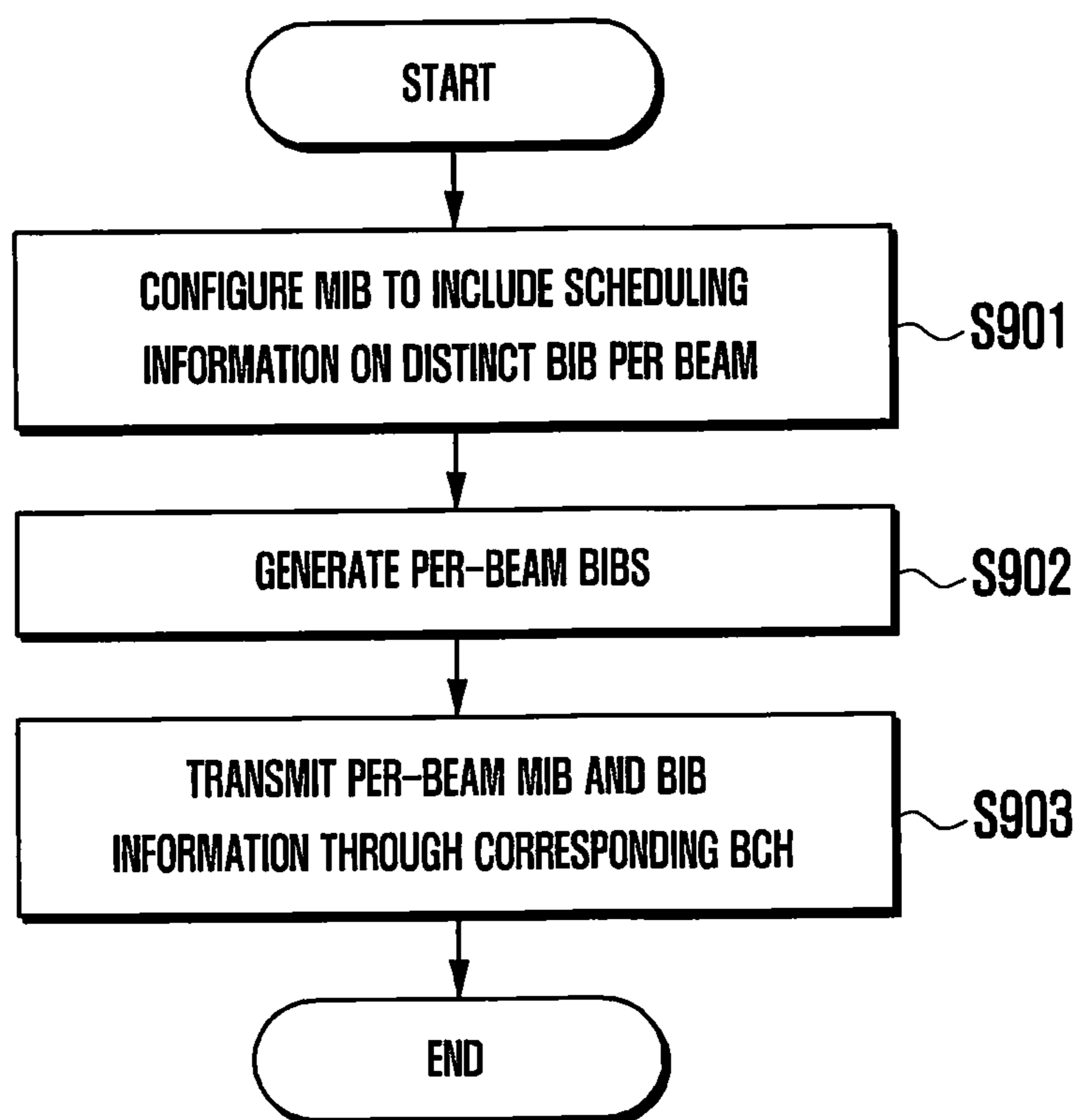


FIG. 9B





**METHOD AND APPARATUS FOR  
TRANSMITTING AND RECEIVING  
COMMON CHANNEL INFORMATION IN  
WIRELESS COMMUNICATION SYSTEM**

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

*More than one Reissue Application has been filed for U.S. Pat. No. 9,948,439. This application is a Continuation Reissue of U.S. application Ser. No. 16/520,809, which is a Reissue Application of U.S. Pat. No. 9,948,439.*

PRIORITY

This application claims priority under 35 U.S.C. 119(a) to applications filed in the Korean Intellectual Property Office on Oct. 24, 2012 and Nov. 6, 2012, and assigned Serial Nos. 10-2012-0118182 and 10-2012-0125012, respectively, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to a wireless mobile communication system and, more particularly, to initial access procedure for a terminal to initially access a base station or a cell, and a method and apparatus for transmitting/receiving common channel information therefore in a mobile communication system supporting a Multiple Input Multiple Output (MIMO) beamforming.

2. Description of the Related Art

Mobile communication systems have evolved into high-speed, high-quality wireless packet data communication systems that provide data and multimedia services beyond those of the early voice-oriented services. Various mobile communication standards, such as, for example, High Speed Downlink Packet Access (HSDPA), High Speed Uplink Packet Access (HSUPA), Long Term Evolution (LTE), and LTE-Advanced (LTE-A) defined in 3<sup>rd</sup> Generation Partnership Project (3GPP), High Rate Packet Data (HRPD) defined in 3<sup>rd</sup> Generation Partnership Project-2 (3GPP2), and 802.16 defined in Institute of Electrical and Electronics Engineers (IEEE), have been developed to support the high-speed, high-quality wireless packet data communication services.

In a wireless mobile communication system, a terminal is required to perform an initial access procedure to communicate with a base station. In the initial access procedure, the terminal receives a synchronization signal or Synchronization Channel (SCH) to acquire downlink synchronization, checks frame timing or a Cell Identifier (ID), and receives unique system information, base station information, or cell information.

Most communication standards adopt a multi-carrier multiple access technique such as, for example, Orthogonal Frequency Division Multiplexing (Multiple Access) (OFDM (A)) using multiple subcarriers. In a multi-carrier multiple access-based wireless mobile communication system, channel estimation and measurement performance is influenced by the number of symbols and the number of subcarriers to

which the reference signal is mapped on the time-frequency resource grid. The channel estimation and measurement performance is also influenced by the power that is allocated for reference signal transmission. Accordingly, by allocating more radio resources (including time, frequency, and power), it is possible to improve the channel estimation and measurement performance, resulting in improved received data symbol demodulation and decoding performance and channel state measurement accuracy.

In a resource-constrained mobile communication system, however, if a radio resource is allocated for transmitting resource signals, the resource amount for data signal transmission is reduced. For this reason, the resource amount for the reference signal transmission is determined by taking the system throughput into account.

Existing 3<sup>rd</sup> generation mobile communications including LTE, Ultra Mobile Broadband (UMB), and 802.16m operate based on a multi-carrier multiple access scheme, and adopt MIMO with channel sensitive scheduling such as, for example, beamforming and Adaptive Modulation and Coding (AMC), to improve transmission efficiency. Furthermore, many efforts are being made to improve the transmission efficiency with technical enhancements of the MIMO and beamforming techniques. One such effort to improve transmission efficiency is Full-Dimension MIMO (FD-MIMO), which is a technique capable of forming various beams with a few dozen antennas.

FD-MIMO is a technique for forming a narrow and long transmit beam to transmit data using a plurality of antennas so as to send the data to a terminal (or User Equipment (UE)) that far from the base station (or evolved Node B (eNB)) at a low transmit power. The FD-MIMO makes it possible to form various types of beams depending on the number of antennas, and also makes it possible to freely adjust the size, distance, and width of a beam according to the weights applied to the antennas, to a certain extent.

FIG. 1 is a diagram illustrating the concept of the FD-MIMO. In FIG. 1, an eNB 101 uses the FD-MIMO technique, and manages three cells 102, 103, and 104. The eNB 101 is required to provide UEs with a data transmission/reception service within the coverage area of the cell 102. The eNB 101 is required to guarantee a satisfactory data transmission to UE 110 located at a cell edge 106. Using the FD-MIMO technique, it is possible to form a narrow beam 112, 113 using several antennas and to concentrate the power within the beam 111, so as to transmit data to the UE 110 at relatively low transmit power, as denoted by reference number 111. Specifically, when it is possible to form a narrow beam with the FD-MIMO, it is also possible to reduce the transmit power for transmitting the same data as compared to the legacy method.

Based on the low transmit power characteristic of the FD-MIMO, the eNB 101 is capable of maintaining the transmit power at a low level within the cell 102. If the eNB is able to maintain the low transmit power level, it is possible to reduce the power range supported by the power amplifier installed in the eNB 101 and, as a consequence, significantly reduce the cost of the power amplifier. Since the cost of the power amplifier is an important factor in determining the eNB installation cost, the FD-MIMO is advantageous in view of the entire system implementation cost. Furthermore, the FD-MIMO is advantageous in that the reduced average power consumption makes it possible to contribute the environment-friendly Green Communication initiative.

In FIG. 1, if the conventional method using no FD-MIMO beamforming is applied, the data transmission coverage is

restricted to the area as denoted by reference number **105** within the area as denoted by reference number **102**.

Even when the eNB **101** transmits data to the UE **110** located at the cell edge at a relatively low transmit power, the data can be delivered to the UE **110** with the beamforming gain. In the case of the data broadcast within a cell, however, it is difficult for the eNB **101** to generate the signal covering the entire cell at the power level determined in consideration of the FD-MIMO power gain. For example, in order to generate the signal which UEs **110**, **121**, and **122** can receive within the cell **102**, it is necessary to allocate a transmit power strong enough to cover the entire cell, which the eNB **101** is not able to support.

There are many signals that should be broadcast within the cell, e.g. common channel information such as an SCH necessary for acquiring synchronization between the UE and the eNB and a Broadcast CHannel (BCH) in which the eNB broadcasts the cell information.

#### SUMMARY OF THE INVENTION

The present invention has been made to address at least the above problems and/or disadvantages and to provide at least the advantages described below. Accordingly, an aspect of the present invention provides a method and apparatus for transmitting distinct synchronization signal and system information depending on the transmission beam for facilitating initial access of the UE in the LTE-A system, which supports MIMO beamforming with a plurality of antennas.

Another aspect of the present invention provides an initial access method that is capable of transmitting signal efficiently at low transmit power level in the FD-MIMO system having a few dozen or more transmit antennas.

In accordance with an aspect of the present invention, a method is provided for transmission of common channel information in a base station of a mobile communication system using multi-antenna-based beamforming. A number of beams to be used for transmission to a terminal is determined. The common channel information is generated corresponding to the number of beams. The common channel information is transmitted through one of the beams.

In accordance with another aspect of the present invention, a method is provided for receiving common channel information at a terminal in a mobile communication system using multi-antenna-based beamforming. The common channel information, transmitted by a base station, is received. Frame timing is acquired based on the common channel information. A signal transmitted by the base station is processed based on the frame timing. The common channel information is generated based on a number of beams used by the base station, and the common channel information is transmitted through one of the beams.

In accordance with another aspect of the present invention, a base station is provided for transmitting common channel information in a mobile communication system using multi-antenna-based beamforming. The base station includes a transceiver configured to transmit and receive signals to and from a terminal. The base station also includes a controller configured to determine a number of beams to be used for transmission to a terminal, generate the common channel information corresponding to the number of beams, and control the transceiver to transmit the common channel information through one of the beams.

In accordance with still another aspect of the present invention, a terminal is provided for receiving common channel information in a mobile communication system using multi-antenna-based beamforming. The terminal

includes a transceiver configured to transmit and receive signals to and from a base station. The terminal also includes a controller configured to control receiving the common channel information transmitted by a base station, acquire frame timing based on the common channel information, and process a signal transmitted by the base station based on the frame timing. The common channel information is generated based on a number of beams used by the base station, and the common channel information is transmitted through one of the beams.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The above and other aspects, features, and advantages of the present invention will be more apparent from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a diagram illustrating the concept of the FD-MIMO;

FIG. **2** is a flowchart illustrating an initial access procedure in the wireless communication system, according to an embodiment of the present invention;

FIG. **3** is a diagram illustrating a frame structure including SCH and BCH for use in an LTE system, according to an embodiment of the present invention;

FIG. **4** is a diagram illustrating a multi-beam-based common channel transmission method, according to an embodiment of the present invention;

FIG. **5** is a diagram illustrating a frame structure for SCH transmission in the LTE system using the beam sweeping technique, according to an embodiment of the present invention;

FIG. **6A** is a block diagram illustrating a configuration of the UE, according to an embodiment of the present disclosure;

FIG. **6B** is a flowchart illustrating the operation procedure of the UE, according to an embodiment of the present invention;

FIG. **7A** is a block diagram illustrating a configuration of the eNB, according to an embodiment of the present invention;

FIG. **7B** is a flowchart illustrating the operation procedure of the eNB, according to an embodiment of the present invention;

FIG. **8A** is a block diagram illustrating the configuration of the UE, according to an embodiment of the present invention; and

FIG. **8B** is a flowchart illustrating the operation procedure of the UE, according to an embodiment of the present invention.

FIG. **9A** is a block diagram illustrating a configuration of the eNB according to an embodiment of the present disclosure; and

FIG. **9B** is a flowchart illustrating the operation procedure of the eNB according to an embodiment of the present disclosure.

#### DETAILED DESCRIPTION OF EMBODIMENTS OF THE PRESENT INVENTION

Embodiments of the present invention are described in detail with reference to the accompanying drawings. The same or similar components may be designated by the same or similar reference numerals although they are illustrated in different drawings. Detailed descriptions of constructions or processes well-known in the art may be omitted to avoid obscuring the subject matter of the present invention. Fur-

ther, the following terms are defined in consideration of their functionality in embodiment of the present invention, and may vary according to the intention of a user or an operator, usage, etc. Therefore, the definition should be made on the basis of the overall content of the present specification.

Although the description is directed to an OFDM-based radio communication system, particularly the 3GPP Evolved Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access (EUTRA), it will be understood by those skilled in the art that embodiments of the present invention can be applied even to other communication systems having a similar technical background and channel format, with a slight modification, without departing from the spirit and scope of the present invention.

In an 3GPP LTE mobile communication system, the UE first performs an initial access procedure for communication with an eNB. The initial access procedure includes acquiring subframe timing synchronization and frame timing synchronization with the eNB, receiving an eNB signal to acquire an ID of the eNB, acquiring system information of the eNB from the received signal, and configuring downlink and uplink for uplink random access.

FIG. 2 is a flowchart illustrating an initial access procedure in the wireless communication system, according to an embodiment of the present invention.

The UE powers on, in step operation 201. The UE searches for an SCH, in step 202. The SCH includes a Primary Synchronization Signal (PSS) (hereinafter, the term 'first synchronization signal' is used interchangeably) and a Secondary Synchronization Signal (SSS) (hereinafter, the term 'second' synchronization signal is used interchangeably). The UE receives the PSS, in step 203, and acquires the subframe time of the eNB based on the PSS. The UE receives the SSS, in step 204, and acquires the accurate frame timing and cell ID of the eNB based on the SSS so as to check the positions of the Cell-specific Reference Signal (CRS) for use in receiving downlink signal.

The UE receives a BCH, in step 205. The BCH includes a Master Information Block (MIB) as unique system information. The MIB includes scheduling information on a System Information Block (SIB) carrying more detailed system information. The MIB is received through BCH, in step 206. The UE acquires scheduling information on the SIB and receives Downlink Shared Channel (DL-SCH) at the corresponding timing based on the SIB scheduling information to acquire the SIB information, resulting in acquisition of entire system information. The SIB information includes operator information, cell bandwidth, neighbor cell information, and random access information. The UE performs random access to establish a communication channel, in step 207, and communicates data with the eNB, in step 208.

FIG. 3 is a diagram illustrating a frame structure including SCH and BCH for use in the current LTE system, according to an embodiment of the present invention.

A radio frame 301 consists of 10 subframes, and the SCH is a carrier in first and sixth subframes 302 and 303 among the 10 subframes. The first subframe also carries BCH 304. Specifically, the first subframe of the radio frame 301 carries both the SCH and BCH.

Each of the SCHs 302 and 303 includes PSS and SSS. The UE receives the SCH 302 and 303 to acquire frame timing. In LTE, the SCHs 302 and 303 use different codes, and each SCH consist of PSS 306 and SSS 305. The PSS provides the UE with one of three possible physical layer identities and

the SSS provides the UE with one of 168 cell layer identities, and thus, there are total 504 possible physical layer cell identities.

The PSS uses the same code at the first and sixth subframe 302 and 303. Accordingly, if PSS is received, the UE acquires the subframe timing so as to receive the SSS preceding right before. Meanwhile, SSS uses different sub-carrier mappings at the first and sixth subframe 302 and 303 and thus the UE is capable of acquiring frame timing with the receipt of only one of two SSS.

As described with reference to FIG. 2, the UE acquires the frame timing and cell ID by receiving SCH including PSS and SSS and checks the position of CRS to receive BCH 304 coherently. The BCH is transmitted only at the first subframe of each radio frame as denoted by reference number 307 of FIG. 3, especially at the first 4 OFDM symbols of the second slot of the first subframe. The UE receives the BCH over several frames to acquire the system information and performs random access and other operation necessary for communication with the eNB.

By taking notice of the beamforming gain expected with FD-MIMO, it is possible to reduce the transmit power level of the UE while maintaining the cell coverage. Although the beamforming is useful for transmitting data to one UE, it cannot be used in broadcast, e.g., a common channel such as SCH and BCH of LTE. This means that the reduced transmit power level of FD-MIMO is not enough to broadcast the common channel, which all of the UEs within the cell must receive.

Embodiments of the present invention proposes a method to transmit the common channel at different timings with several beams to cover an entire cell area.

FIG. 4 is a diagram illustrating a multi-beam-based common channel transmission method, according to an embodiment of the present invention.

As shown in FIG. 4, the cell under control of an eNB 401 is covered by [four] five beams 402 to 406. Since one beam, e.g. beam 402, which is formed with the transmit power available at the eNB 401, cannot cover the entire cell, it is difficult to allow all the UEs within the cell to receive the common channel broadcast by the eNB 401. As shown in the embodiment of FIG. 4, it is impossible for UEs 411 and 412 to receive the same information carried by one beam.

Embodiments of the present invention propose a beam sweeping technique which forms several distinct beams at different times. Specifically, the first beam 402 is formed at the first time, the second beam 403 at the second time, the third beam 404 at the third time, the fourth beam 405 at the fourth time, and the fifth beam 406 at the fifth time.

Although FIG. 4 is directed to the case of using 5 beams for covering the entire cell, the number of beams may be determined or variable depending on the real system environment. The UE 411 may receive the common channel through the second beam 403, and the UE 412 located at the intersection of the third and fourth beams 404 and 405 may receive the common channel through both the fourth and fifth beams 404 and 405. The five beams 402 to 406 may carry the same information or distinct information. Descriptions are made of the definitions on the SCH and BCH for use in initial access, the method for the eNB to transmit the common channel, and UE operation of receiving the common channel in the case of using the beam sweeping technique. In embodiments of the present invention, the term 'beam' may denote a signal transmitted through a beam formed with a plurality of antenna and a beam coverage in

which the signal is receivable. Accordingly, the term ‘beam’ may be substituted by a term incorporating the above meaning.

A description is made of the FD-MIMO technique as a basis of embodiments of the present invention.

In an embodiment of the present invention, SCH transmission is provided using beam sweeping. As described above, the UE performs an initial access procedure to connect to the eNB and, in the case of using the FD-MIMO, the UE needs to use beam sweeping for transmitting down-link common channel necessary for the initial access. Although this embodiment of the present invention is directed to an LTE system frame structure and initial access procedure, the frame structure, number of beams, and other details may be changed without departing from the scope of the subject matter described in embodiments of the present invention.

When using the beam sweeping technique, the common channel, such as SCH, is transmitted over all of the beams. In order to transmit the SCH arranged at two subframes of one radio frame, as shown in FIG. 3, over several beams at different timings, it is necessary to use the resources at several different timings for SCH transmission.

FIG. 5 is a diagram illustrating a frame structure for SCH transmission in the LTE system using the beam sweeping technique, according to an embodiment of the present invention. The SCH appearing at subframes 501 and 506 are arranged as in the legacy LTE system. In the case of using the beam sweeping, the SCHs at the subframes 501 and 506 are transmitted over one of the beams 402 to 406 of FIG. 4, such that it is difficult for all the UEs within the cell to receive the SCH carried at the subframes 501 and 506.

In an embodiment of the present invention, extra SCH is generated per beam as shown in FIG. 5. When using 5 beams as shown in FIG. 4, 5 beam-specific SCHs (i.e. SCH1 501 and 506, SCH2 502 and 507, SCH3 503 and 508, SCH4 504 and 509, and SCH5 505 and 510) have to be generated and transmitted on the respective beam at different timings. The SCH number and beam number may be mapped randomly, and the orders of SCHs and beams may match each other or mapped to each other randomly.

Although this embodiment of the present invention is directed to the case of using the 5 beams and 5 SCHs, if the number of beams is less than 5, it is possible to select SCHs matching the beams in number and determine the SCH positions randomly or according to a predetermined rule. As the rule of determining the SCH positions, a method of selecting the subframes as many as the required number of SCHs from the first subframe may be used.

The PSS is transmitted as SCH-specific code, i.e. the code determined differently depending on the beam. This means that the PSS is restricted depending on the subframe, such that the UE is capable of checking the position of the subframe carrying the current SCH only by receiving one SCH. In this case, if the UE receives PSS and SSS codes of the SCH determined based on the received beam, it is possible to determine the subframe carrying the current SCH in the radio frame regardless of the location of the UE within the cell. The different PSS codes may be generated in such a way of generating a reference PSS code and shifting the reference PSS code cyclically. Also, the different PSS codes may be generated in such a way of performing scrambling on the reference PSS code.

FIGS. 6A and 6B show the operations of the UE receiving SCH in the case of applying the beam sweeping, according to an embodiment of the present invention. FIG. 6A is a block diagram illustrating a configuration of the UE accord-

ing to an embodiment of the present invention, and FIG. 6B is a flowchart illustrating the operation procedure of the UE according to an embodiment of the present invention.

The UE receives SCH by means of a receiver 601, in step S601. The UE detects the codes of the PSS and SSS included in the SCH by means of a code detector 602, in step S602. The UE acquires the frame timing with the received code by means of a controller 603, in step S603. The UE decodes the signal received by the receiver 601 according to the frame timing under the control of the controller 603 by means of the decoder 604, in step S604.

The decoder 604 may be used for decoding the signal such as BCH and PDSCH.

FIGS. 7A and 7B show the operations of the eNB transmitting SCH in the case of applying the beam sweeping, according to an embodiment of the present invention. FIG. 7A is a block diagram illustrating a configuration of the eNB according to an embodiment of the present invention, and FIG. 7B is a flowchart illustrating the operation procedure of the eNB according to an embodiment of the present invention.

A SCH code generator 701 checks the number of beams to be used, in step S701. The SCH code generator 701 generates the codes to be included in the SCH, i.e. PSS and SSS corresponding to the number of beams, to a transmitter 703.

The transmitter 703 transmits SCH, including the code determined by a controller 702, using the beam determined by the controller 702, at the subframe determined by the controller 702, under control of the controller 702, in step S703.

In another embodiment of the present invention BCH transmission is performed using beam sweeping. This embodiment is directed to the BCH reception according to the UE location.

In the case of using the beam [steeping] *sweeping* technique proposed in embodiments of the present invention, the SCH is transmitted at every subframe in the LTE system as shown in FIG. 5. BCH is mapped to the four OFDM symbols right after the SCH in the subframe carrying the first one of the two paired SCHs as denoted by reference number 513 of FIG. 5. Similar to SCH, if the beam sweeping is applied to BCH, the BCH is transmitted over the subframes 501 to 505.

The BCH is received at the BCH positions determined based on the frame timing acquired through SCH. The BCH carries the MIB as the cell-specific information and includes SIB scheduling information for use in SIB as more detailed system information. For the beam sweeping with the FD-MIMO, an embodiment of the present invention introduces beam-specific information (hereinafter, referred to as BIB). The UE receives the MIB through BCH transmitted by the eNB, and the MIB includes the scheduling information on BIB. The UE receives a different MIB depending on the beam transmitted by the eNB, so as to receive the distinct BIB according to the received beam. If the UE receives the BCH through a certain beam, it acquires the system information corresponding to the received beam. Specifically, since the different information is received depending on the beam, the BCH is configured in the way of receiving different BIBs through different beams. The cell-specific information is transmitted in the same MIB through all the beams carrying BCHs.

Referring to FIG. 5, the BCH transmitted at the subframe 501 includes the MIB corresponding to beam 1, and the MIB includes the SIB as the cell-specific information and the scheduling information for use in the BIB corresponding to beam 1 among the five beams. The BCH transmitted at the

subframe **502** includes the MIB corresponding to beam **2** and, the MB includes the SIB as the cell-specific information and scheduling information for use in receiving BIB corresponding to beam **2** among the five beams. The BCH transmitted at the subframe **503** includes the MIB corresponding to beam **3** and, the MIB includes the SIB as the cell-specific information and scheduling information for use in receiving BIB corresponding to beam **3** among the five beams. The BCH transmitted at the subframe **504** includes the MIB corresponding to beam **4** and, the MIB includes the SIB as the cell-specific information and scheduling information for use in receiving BIB corresponding to beam **4** among the five beams. The BCH transmitted at the subframe **505** includes the MIB corresponding to beam **5** and, the MIB includes the SIB as the cell-specific information and scheduling information for use in receiving BIB corresponding to beam **5** among the five beams. The BIB may include other information necessary for transmitting and receiving the signals using the beam pattern, for example, uplink random access parameter information, power control information, and TDD downlink/uplink configuration information. Particularly, the uplink random access information includes the information on the resource for transmitting Uplink Random Access Channel (UL RACH) and, if different UL RACH resources are used for respective beams, the eNB is capable of checking when the UE transmits the UL RACH so as to improve the reception beamforming gain and, if the same beam is used in transmitting the response in replay to the UL-RACH, transmission beamforming gain. If the type of the beam to receive changes due to the change of the UE location within the cell, the BIB also has to change in corresponding to the new beam. At this time, the BIB may be transmitted to the UE through the BCH corresponding to the new beam or DL-SCH.

In another embodiment of the present invention, BCH is interpreted according to beam sweeping. This embodiment is directed to an uplink random access method according to the UE location. In the first described embodiment using the beam sweeping, the beam-specific SCH is transmitted in the way of transmitting SCH per subframe, such that the UE acquires the frame timing. In the case of an LTE system, SCH is transmitted at every subframe, and the BCH is mapped to four OFDM symbols following the SCH at the subframes carrying the first of the two paired SCHs as denoted by reference number **513** of FIG. **5**. Like SCH, if the beam sweeping is used, the BCH is transmitted at the subframes **501** to **505**. In an embodiment of the present invention, BCH includes the information on a relationship between SCH and beam and UE operation dependent on the beam. Specifically, the UE that has received SCH is capable of acquiring the information on the currently received beam through BCH. The UEs that receive SCH at different subframes receive different beams, resulting in acquisition of different information. The UE receives different BCH information, i.e., different MIB information indicating the location of the BIB, interpreted according to the received beam as well as the beam information. The information-beam specific information may include the other information necessary for transmitting and receiving signal using the beam pattern such as UL random access parameter information, power control information, and TDD DL/UL configuration information.

FIGS. **8A** and **8B** illustrate operations of the UE when the BCH interpretation method changes according to the beam in the beam sweeping-based method, according to an embodiment of the present disclosure. FIG. **8A** is a block diagram illustrating the configuration of the UE, according

to an embodiment of the present invention. FIG. **8B** is a flowchart illustrating the operation procedure of the UE, according to an embodiment of the present invention.

The UE receives SCH by means of a receiver **801** and an SCH detector **802**, in step **S801**. The UE reads BCH by means of a BCH decoder **803**, in step **S802**.

The receiver inputs the SCH information and BCH information, i.e., MIB information, to a controller **804**, in step **S803**. The controller **804** acquires scheduling information from BIB transmitted in the two pieces of information, in step **S804**, and controls the receiver **801** based on the scheduling information to receive DL-SCH at the BIB transmission position and acquire the BIB information at a BIB receiver **805**, in step **S805**.

The BIB information is input to a transmission controller **806**, and the transmission controller **806** acquires the UL random access information, particularly UL-RACH resource information, included in the BIB, in step **S806**. Then the transmission controller controls a transmitter **807** based on the UL random access information, such that the UE performs UL random access on the resource indicated by UL-RACH resource information included in the BIB, in step **S807**.

FIGS. **9A** and **9B** are diagrams illustrating operations of the eNB for transmitting per-beam BCH and BIB in the case of applying the beam sweeping, according to an embodiment of the present invention. FIG. **9A** is a block diagram illustrating a configuration of the eNB according to an embodiment of the present invention, and FIG. **9B** is a flowchart illustrating the operation procedure of the eNB according to an embodiment of the present invention.

A controller **901** controls an MIB generator **902** to include the scheduling information on the beam-specific BIB in the MIB, in step **S901**.

The controller **901** controls a BIB generator **903** to generate the beam-specific BIB, in step **S902**, and controls a transmitter **904** to transmit the beam-specific MIB and BIB information using the corresponding BCH and DL-SCH, in step **S903**. The controller **901** controls a receiver **905** to receive UL-RACH transmitted by the UE receiving a predetermined beam.

The signal transmission/reception method of embodiments of the present invention is capable of efficiently performing the initial access at a low transmit power level in the FD-MIMO system having a few dozen or more transmit antennas.

Although the internal structures of the UE and the eNB of embodiments of the present invention have been described with reference to the accompanying drawings, each of the UE and the eNB may be configured with a transceiver for transmitting/receiving signal to/from the peer node and a controller for controlling its functions. The controller's functions of each node have been described in detailed at the respective parts.

While the invention has been shown and described with reference to certain embodiments thereof, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

**[1]** A method by a base station of a mobile communication system using multi-antenna-based, beamforming, the method comprising:

identifying a plurality of beams to be used for transmission; and

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transmitting, to each terminal in a cell of the base station,  
 common channel information through each of the plu-  
 rality of the beams,  
 wherein the common channel information is information  
 to be commonly applied to terminals which belong to 5  
 the cell of the base station,  
 wherein the common channel information comprises a  
 synchronization channel including a first synchroniza-  
 tion signal and a second synchronization signal, and  
 wherein the common channel information transmitted 10  
 through each of the plurality of beams to each terminal  
 is included in different subframes in a frame and the  
 first synchronization signal includes a beam-specific  
 code, which is a synchronization channel-specific code  
 determined differently depending on the beam, such 15  
 that each terminal identifies a subframe carrying the first  
 synchronization signal based on the beam-specific code  
 for acquiring frame timing.]

[2. The method of claim 1, wherein the common channel  
 information further comprises a broadcast channel.] 20

[3. The method of claim 2, wherein the broadcast channel  
 comprises a master information block as cell-specific infor-  
 mation, the master information block comprising scheduling  
 information on beam-specific information including system  
 information on a certain beam, the beam-specific informa- 25  
 tion comprising at least one of uplink random access infor-  
 mation, power control information, Time Division Duplex  
 (TDD) downlink/uplink configuration information.]

[4. A method by a terminal in a mobile communication  
 system using multi-antenna-based beamforming, the method 30  
 comprising:

receiving common channel information transmitted  
 through a beam by a base station, wherein the common  
 channel information is included in a certain subframe in  
 a frame and comprises a synchronization channel 35  
 including a first synchronization signal and a second  
 synchronization signal, the first synchronization signal  
 including a beam-specific code, which is a synchroni-  
 zation channel-specific code determined differently  
 depending on the beam, 40

identifying the subframe carrying the first synchroniza-  
 tion signal based on the beam-specific code;

acquiring frame timing based on a result of the identifi-  
 cation of the subframe; and

receiving a signal transmitted by the base station based on 45  
 the frame timing,

wherein the common channel information is transmitted  
 through each of a plurality of beams, and the common  
 channel information transmitted through each of the  
 plurality of beams is included in different subframes in 50  
 a frame,

wherein the common channel information is information  
 to be commonly applied to terminals which belong to  
 a cell of the base station.]

[5. The method of claim 4, wherein the common channel 55  
 information further comprises a broadcast channel.]

[6. The method of claim 5, wherein the broadcast channel  
 comprises a master information block as cell-specific infor-  
 mation, the master information block comprising scheduling  
 information on beam-specific information including system 60  
 information on a certain beam, the beam-specific informa-  
 tion comprising at least one of uplink random access infor-  
 mation, power control information, Time Division Duplex  
 (TDD) downlink/uplink configuration information.]

[7. A base station in a mobile communication system 65  
 using multi-antenna-based beamforming, the base station  
 comprising:

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a transceiver configured to transmit and receive signals;  
 and

a controller configured to identify a plurality of beams to  
 be used for transmission, and control the transceiver to  
 transmit, to each terminal in a cell of the base station,  
 common channel information through each of the plu-  
 rality of the beams,

wherein the common channel information is information  
 to be commonly applied to terminals which belong to  
 the cell of the base station,

wherein the common channel information comprises a  
 synchronization channel including a first synchroniza-  
 tion signal and a second synchronization signal, and  
 wherein the common channel information transmitted

through each of the plurality of beams to each terminal  
 is included in different subframes in a frame and the  
 first synchronization signal includes a beam-specific  
 code, which is a synchronization channel-specific code  
 determined differently depending on the beam, such 15  
 that each terminal identifies a subframe carrying the  
 first synchronization signal based on the beam-specific  
 code for acquiring frame timing.]

[8. The base station of claim 7, wherein the common  
 channel information further comprises a broadcast channel.]

[9. The base station of claim 8, wherein the broadcast  
 channel comprises a master information block as cell-  
 specific information, the master information block compris-  
 ing scheduling information on beam-specific information  
 including system information on a certain beam, the beam- 25  
 specific information comprising at least one of uplink ran-  
 dom access information, power control information, Time  
 Division Duplex (TDD) downlink/uplink configuration  
 information.]

[10. A terminal in a mobile communication system using  
 multi-antenna-based beamforming, the terminal comprising:

a transceiver configured to transmit and receive signals to  
 and from a base station; and

a controller configured to control the transceiver to:  
 receive common channel information transmitted through  
 a beam by a base station, wherein the common channel  
 information is included in a certain subframe in a frame  
 and comprises a synchronization channel including a  
 first synchronization signal and a second synchroniza-  
 tion signal, the first synchronization signal including a  
 beam-specific code, which is a synchronization chan-  
 nel-specific code determined differently depending on  
 the beam, 40

identify the subframe carrying the first synchronization  
 signal based on the beam-specific code,

acquire frame timing based on a result of the identification  
 of the subframe, and

receive a signal transmitted by the base station based on  
 the frame timing,

wherein the common channel information is transmitted  
 through each of a plurality of beams and the common  
 channel information transmitted through each of the  
 plurality of beams is included in different subframes in  
 a frame, 50

wherein the common channel information is information  
 to be commonly applied to terminals which belong to  
 a cell of the base station.]

[11. The terminal of claim 10, wherein the common  
 channel information further comprises a broadcast channel.]

[12. The terminal of claim 11, wherein the broadcast  
 channel comprises a master information block as cell-  
 specific information, the master information block compris-  
 ing scheduling information on beam-specific information

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including system information on a certain beam, the beam-specific information comprising at least one of uplink random access information, power control information, Time Division Duplex (TDD) downlink/uplink configuration information.]

13. A terminal for processing synchronization signals and system information in a mobile communication system, the terminal comprising:

a transceiver; and

a processor configured to:

receive, from a base station via the transceiver, a block including a primary synchronization signal (PSS), a secondary synchronization signal (SSS), and a broadcast channel (BCH), wherein the block is one among a set of blocks and each block in the set of blocks is a candidate for receiving the PSS, SSS and the BCH,

obtain master information in the BCH of the block, and

receive, from the base station via the transceiver, system information in a downlink shared channel based on the master information in the BCH of the block, wherein the set of blocks are defined based on a time duration corresponding to 5 sub-frames of 10 sub-frames within one frame,

wherein the PSS of the block is separated from the SSS and the BCH in a time domain,

wherein random access information associated with the block is included in the system information,

wherein the block is associated with a beam-specific code and a beam of at least one beam for the set of blocks, wherein the set of blocks are indexed in an ascending order in the time domain,

wherein a time synchronization is identified based on the block associated with the beam-specific code, and

wherein the system information includes cell-specific information.

14. The terminal of claim 13, wherein each block among the set of blocks is numbered and a position of the block is predetermined.

15. The terminal of claim 13, wherein the processor is further configured to identify a cell identifier (ID) based on the block.

16. The terminal of claim 13, wherein a subset of blocks transmitted from the base station is determined.

17. The terminal of claim 13, wherein the random access information associated with the block includes information on resources for transmitting a physical random access channel.

18. A base station for processing synchronization signals and system information in a mobile communication system, the base station comprising:

a transceiver; and

a processor configured to:

transmit, to a terminal via the transceiver, a block including a primary synchronization signal (PSS), a secondary synchronization signal (SSS), and a broadcast channel (BCH), wherein the block is one among a set of blocks and each block in the set of blocks is a candidate for receiving the PSS, SSS and the BCH, and

transmit, to the terminal via the transceiver, system information in a downlink shared channel based on master information in the BCH,

wherein the set of blocks are defined based on a time duration corresponding to 5 sub-frames of 10 sub-frames within one frame,

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wherein the PSS of the block is separated from the SSS and the BCH in a time domain,

wherein the master information is transmitted in the BCH, wherein random access information associated with the block is included in the system information,

wherein the block is associated with a beam-specific code and a beam of at least one beam for the set of blocks, wherein the set of blocks are indexed in an ascending order in the time domain,

wherein a time synchronization is identified based on the block associated with the beam-specific code, and wherein the system information includes cell-specific information.

19. The base station of claim 18, wherein each block among the set of blocks is numbered and a position of the block is predetermined.

20. The base station of claim 18, wherein a cell identifier (ID) is identified based on the block.

21. The base station of claim 18, wherein the processor is further configured to determine a subset of blocks to be transmitted.

22. The base station of claim 18, wherein the random access information associated with the block includes information on resources for transmitting a physical random access channel.

23. A method for processing synchronization signals and system information in a mobile communication system, the method comprising:

receiving, from a base station, a block including a primary synchronization signal (PSS), a secondary synchronization signal (SSS), and a broadcast channel (BCH), wherein the block is one among a set of blocks and each block in the set of blocks is a candidate for transmitting the PSS, SSS and the BCH;

obtaining master information in the BCH of the block; and

receiving, from the base station, system information in a downlink shared channel based on the master information in the BCH of the block,

wherein the set of blocks are defined based on a time duration corresponding to 5 sub-frames of 10 sub-frames within one frame,

wherein the PSS of the block is separated from the SSS and the BCH in a time domain,

wherein random access information associated with the block is included in the system information,

wherein the block is associated with a beam-specific code and a beam of at least one beam for the set of blocks, wherein the set of blocks are indexed in an ascending order in the time domain,

wherein a time synchronization is identified based on the block associated with the beam-specific code, and

wherein the system information includes cell-specific information.

24. The method of claim 23, wherein each block among the set of blocks is numbered and a position of the block is predetermined.

25. The method of claim 23, further comprising identifying a cell identifier (ID) based on the block.

26. The method of claim 23, wherein a subset of blocks transmitted from the base station is determined.

27. The method of claim 23, wherein the random access information associated with the block includes information on resources for transmitting a physical random access channel.

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28. A method for processing synchronization signals and system information in a mobile communication system, the method comprising:

transmitting, to a terminal, a block including a primary synchronization signal (PSS), a secondary synchroni- 5 zation signal (SSS), and a broadcast channel (BCH), wherein the block is one among a set of blocks and each block in the set of blocks is a candidate for transmitting the PSS, SSS and the BCH; and

transmitting, to the terminal, system information in a 10 downlink shared channel based on master information in the BCH,

wherein the set of blocks are defined based on a time duration corresponding to 5 sub-frames of 10 sub-frames within one frame,

wherein the PSS of the block is separated from the SSS and the BCH in a time domain,

wherein the master information is transmitted in the BCH, wherein random access information associated with the block is included in the system information,

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wherein the block is associated with a beam-specific code and a beam of at least one beam for the set of blocks, wherein the set of blocks are indexed in an ascending order in the time domain,

wherein a time synchronization is identified based on the block associated with the beam-specific code, and wherein the system information includes cell-specific information.

29. The method of claim 28, wherein each block among 10 the set of blocks is numbered and a position of the block is predetermined.

30. The method of claim 28, wherein a cell identifier (ID) is identified based on the block.

31. The method of claim 28, further comprising deter- 15 mining a subset of blocks to be transmitted.

32. The method of claim 28, wherein the random access information associated with the block includes information on resources for transmitting a physical random access channel.

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