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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 February 2008 (21.02.2008)

PCT

(10) International Publication Number
WO 2008/021498 A2

(51) International Patent Classification:
H04Q 7/20 (2006.01)

(21) International Application Number:
PCT/US2007/018266

(22) International Filing Date: 17 August 2007 (17.08.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/838,550 17 August 2006 (17.08.2006) US

(71) Applicant *(for all designated States except US)*: **RADIOFRAME NETWORKS, INC.** [US/US]; 9461 Willows Road Ne, Suite 100, Redmond, WA 98052 (US).

(72) Inventors: **ZHANG, Yan**; 9461 Willows Road NE, Suite 100, Redmond, WA 98052 (US). **SUKUMARAN, Jayesh**; 9461 Willows Road Ne, Suite 100, Redmond, WA 98052 (US). **HOOLE, Elliott**; 9461 Willows Road NE, Suite 100, Redmond, WA 98052 (US). **VEINTIMILLA, Greg**; 9461 Willows Road NE, Suite 100, Redmond, WA 98052 (US).

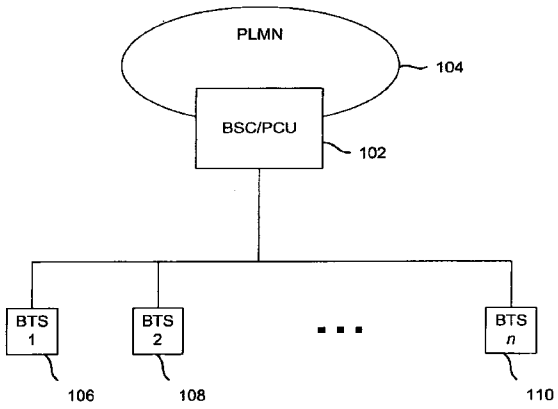
(74) Agent: **JAMES, William, J.**; Van Pelt, Yi & James LLP, 10050 N.foothill Blvd, Suite 200, Cupertino, CA 95014 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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

(54) **Title:** USING A SINGLE LOGICAL BASE TRANSCEIVER TO SERVE MULTIPLE PHYSICAL LOCATIONS



(57) **Abstract:** Using a single logical base transceiver to serve multiple physical locations is disclosed. A call traffic associated with a call associated at a mobile network with an assigned timeslot of a logical base transceiver is received. A timeslot with which the call traffic is associated is remapped from the assigned timeslot to a serving timeslot being used at a serving physical base transceiver to facilitate the call, in the event the call traffic comprises inbound call traffic being sent into the mobile network from the serving physical base transceiver, or from the serving timeslot to the assigned timeslot in the event the call traffic comprises outbound call traffic being sent from the mobile network to the serving physical base transceiver.

WO 2008/021498 A2

USING A SINGLE LOGICAL BASE TRANSCEIVER TO SERVE MULTIPLE PHYSICAL LOCATIONS

CROSS REFERENCE TO OTHER APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 60/838,550 entitled USING A SINGLE LOGICAL BASE TRANSCEIVER TO SERVE MULTIPLE PHYSICAL LOCATIONS filed August 17, 2006, which is incorporated herein by reference for all purposes.

BACKGROUND OF THE INVENTION

[0002] Traditional base transceiver stations (BTS) are large, immobile installations configured to provide mobile telecommunication service to users in a relatively large surrounding geographic area or "cell". A traditional BTS typically includes multiple transceivers (TRX), each operating at an assigned frequency and in the case of a GSM installation. In the case of GSM, time division multiple access (TDMA) is used to enable a single TRX to be used to transmit/receive on eight timeslots, each timeslot capable of carrying traffic for a corresponding signaling or traffic channel.

[0003] A traditional BTS typically provides connectivity to a public land mobile network (PLMN) via a dedicated wired connection, e.g., a T-1 or E-1 line, to a base station controller (BSC). The BSC typically provides such connectivity for a plurality of base transceiver stations. Typically, a BSC is limited to supporting up to a certain maximum number of base transceiver stations (BTS) and a corresponding and typically larger maximum number of transceivers (TRX). For example, a BSC may be able to support up to a maximum of 300 BTS's and up to 900 TRX's. To fully utilize the capacity of such a BSC, each BTS would have to include on average three TRX's.

[0004] Small scale base transceiver stations (sometimes referred to herein by the acronym "S-BTS"), such as a micro-, pico-, or femto-base transceiver stations

(micro-, pico-, or femto-BTS), have been developed to provide relatively low volume mobile telecommunications service to specific areas and/or users (e.g., a residence, a business, and/or a remote area). A small scale BTS may not need anywhere near the call capacity of a traditional BTS. For a small scale BTS deployed to serve a single residence, for example, utilization may be such that only a single TRX, or even fewer timeslots than a single TRX would provide may be needed. As a result, deploying numerous small scale BTS's in a service area served by a typical single BSC, each with only one (or fewer) TRX, might result in underutilization of the BSC's resources. For example, in the example described above the BSC is configured to support a maximum of 300 BTS's and 900 TRX's. If each of the 300 BTS's were an S-BTS having only one TRX, then the BSC would support only 300 TRX's, leaving the BSC's ability to support 600 more TRX's unused.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Various embodiments of the invention are disclosed in the following detailed description and the accompanying drawings.

[0006] Figure 1 is a block diagram illustrating an embodiment of elements of a mobile telecommunications network.

[0007] Figure 2 is a block diagram illustrating an embodiment of a set of transceivers (TRX) comprising a base transceiver station (BTS).

[0008] Figure 3 is a block diagram illustrating an embodiment of a system for using a single logical BTS to provide mobile telecommunication service via a plurality of physical base transceiver stations.

[0009] Figure 4 is a block diagram illustrating an embodiment of timeslot remapping.

[0010] Figure 5 is a block diagram illustrating an embodiment of a set of base stations in which a logical TRX is to support multiple physical TRX's, each having fewer than a full (e.g., eight) number of usable timeslots.

[0011] Figure 6 is a block diagram illustrating an embodiment of a set of base stations in which a logical TRX is to support multiple physical TRX's, each having fewer than a full (e.g., eight) number of usable timeslots.

[0012] Figure 7 is a flow chart illustrating an embodiment of a process for using a single logical BTS to provide mobile service via a plurality of physical BTS's.

[0013] Figure 8 is a flow chart illustrating an embodiment of a process for using a single logical BTS to provide mobile service via a plurality of physical BTS's.

[0014] Figure 9 is a flow chart illustrating an embodiment of a process for handling inbound call traffic.

[0015] Figure 10 is a flow chart illustrating an embodiment of a process for handling outbound call traffic.

[0016] Figure 11 is a block diagram illustrating an embodiment of a system for using a single logical BTS to provide mobile service via a plurality of physical BTS's.

[0017] Figure 12 is a block diagram illustrating an embodiment of a system for using a single logical BTS to provide mobile service via a plurality of physical BTS's.

[0018] Figure 13 is a flow chart illustrating an embodiment of a process for using frequency remapping to enable a single logical BTS to be used to provide mobile services via multiple physical BTS's.

[0019] Figure 14 is a flow chart illustrating an embodiment of a process for handling inbound call traffic in an environment in which frequency remapping is being used to enable a single logical BTS to be used to provide mobile services via multiple physical BTS's.

[0020] Figure 15 is a flow chart illustrating an embodiment of a process for handling outbound call traffic in an environment in which frequency remapping is

being used to enable a single logical BTS to be used to provide mobile services via multiple physical BTS's.

DETAILED DESCRIPTION

[0021] The invention can be implemented in numerous ways, including as a process, an apparatus, a system, a composition of matter, a computer readable medium such as a computer readable storage medium or a computer network wherein program instructions are sent over optical or communication links. In this specification, these implementations, or any other form that the invention may take, may be referred to as techniques. A component such as a processor or a memory described as being configured to perform a task includes both a general component that is temporarily configured to perform the task at a given time or a specific component that is manufactured to perform the task. In general, the order of the steps of disclosed processes may be altered within the scope of the invention.

[0022] A detailed description of one or more embodiments of the invention is provided below along with accompanying figures that illustrate the principles of the invention. The invention is described in connection with such embodiments, but the invention is not limited to any embodiment. The scope of the invention is limited only by the claims and the invention encompasses numerous alternatives, modifications and equivalents. Numerous specific details are set forth in the following description in order to provide a thorough understanding of the invention. These details are provided for the purpose of example and the invention may be practiced according to the claims without some or all of these specific details. For the purpose of clarity, technical material that is known in the technical fields related to the invention has not been described in detail so that the invention is not unnecessarily obscured.

[0023] Using a single logical base station and/or transceiver to be used to provide mobile telecommunication service via a plurality of physical base stations and/or transceivers is disclosed. In some embodiments, a single logical base transceiver station (BTS) and/or transceiver (TRX) from the perspective of the mobile network is used to provide service via multiple small scale base transceiver stations

(S-BTS), each potentially in a different geographic location. In some embodiments, timeslot remapping is employed to enable a call associated from the perspective of a mobile network (e.g., PLMN) with a particular BSC, TRX, and/or timeslot thereof to be connected and provided via an S-BTS, e.g., via a particular timeslot of a single physical TRX of the S-BTS. Outgoing traffic associated from the perspective of the mobile network with a timeslot of a logical BTS and/or associated TRX is remapped to a timeslot with which the call is associated at the S-BTS via which the call is being provided, i.e., the timeslot actually being used at the servicing S-BTS to send/receive to/from the mobile station (MS) call data associated with the call. Likewise, incoming traffic received from the S-BTS is remapped to the logical BSC and/or TRX timeslot with which the call is associated at the mobile network (e.g., BSC). In some embodiments, frequency remapping is used to enable a logical BSC and/or TRX to be used to provide mobile telecommunication service via a plurality of small scale base transceiver stations. In some embodiments, each S-BTS has a single transceiver with a same number of timeslots as one or more logical transceivers from the perspective of the mobile network, each transceiver having associated with it a corresponding transmit frequency. An S-BTS via which a call is connected is configured to operate, on a same timeslot as a logical TRX timeslot with which the call is associated at the mobile network, at a frequency associated with a logical TRX with which the call is associated at the mobile network.

[0024] Figure 1 is a block diagram illustrating an embodiment of elements of a mobile telecommunications network. A base station controller/packet control unit 102 provides access to a public land mobile network (PLMN) 104 to mobile stations (MS) present within the respective coverage area of one or more of a plurality of *n* base transceiver stations (BTS), represented in Figure 1 by BTS's 106, 108, and 110. Each BTS is connected to the BSC 102 via a dedicated T-1, E-1, or similar connection.

[0025] Figure 2 is a block diagram illustrating an embodiment of a set of transceivers (TRX) comprising a base transceiver station (BTS). In the example shown, BTS 106 comprises three transceivers, TRX 1, TRX 2, and TRX 3, each having eight timeslots. For convenience and clarity in the discussion below, the

combined 24 timeslots of the three TRX's comprising BTS 106 in this example have been numbered consecutively as timeslots 0-23. In the example shown, timeslot 0 is cross-hatched to indicate it has been assigned to carry messages associated with the broadcast or beacon channel (BCCH) for the BTS 106. Only one timeslot on one transceiver need carry the BCCH traffic in a traditional BTS, since that is sufficient to enable MS's within a coverage area of the BTS to receive the BCCH transmissions. In this example, timeslots 13, 14, and 15 (i.e., timeslots 5-7 of TRX 2) have been designated to handle all packet data traffic (packet data channels or PDCH) sent/received via the BTS. The remaining twenty timeslots, 1-12 and 16-23 in this example, would be available to be assigned to serve as traffic channels (TCH), each for a corresponding call, for example.

[0026] Figure 3 is a block diagram illustrating an embodiment of a system for using a single logical BTS to provide mobile telecommunication service via a plurality of physical base transceiver stations. In the example shown, an aggregating gateway (AGW) 302 is connected via an IP network 304, e.g., the Internet, to a plurality of small scale base transceiver stations (S-BTS), represented in Figure 3 by S-BTS's 306, 308, 310. The AGW 302 provides connectivity to PLMN 104 via BSC 102. In the example shown, the number of small scale base transceiver stations m is greater than a maximum number n of BTS's that the BSC is configured and/or capable of being provisioned to support. In some embodiments, each S-BTS has a single transceiver, such that the total number of transceivers (TRX) m is less than a maximum number of TRX's that the BSC 102 is able to support. Using timeslot remapping to enable the m physical S-BTS's and/or associated TRX's to be served using $n < m$ or fewer logical BTS's from the perspective of BSC 102 is disclosed. For example, in some embodiments the three TRX's illustrated in Figure 2 as being associated with a traditional large scale BTS 106 would represent a single logical BTS and associated logical TRX timeslots 0-23. Each call associated from the perspective of BSC 102 with an assigned one of the logical TRX timeslots 0-23 would in practice be remapped to a corresponding timeslot on a physical TRX of an S-BTS via which the call is being provided, i.e., the actual timeslot via with the S-BTS sends/receives data associated with the call.

[0027] Figure 4 is a block diagram illustrating an embodiment of timeslot remapping. In the example shown, the single logical BTS 106 and associated logical TRX's of Figure 2 are used to provide mobile telecommunication services via a set of five S-BTS's, each having a corresponding TRX as shown in Figure 4 (TRX's S1-S5). In the example shown, the broadcast control channel (BCCH) associated with logical timeslot 0 of BTS 106 is propagate to the respective first timeslot (402) of each of the five S-BTS's. The packet data channels (PDCH) assigned to logical timeslots 13-15 are remapped to the sixth through eighth timeslots of each S-BTS TRX (404). The remaining twenty timeslots (406) are available to serve as call traffic channels (TCH). In some embodiments, as a call is set up, the AGW 302 or another node observes the logical timeslot to which the call is assigned and establishes a mapping between that logical timeslot and a physical TRX timeslot that will be used to send/receive traffic associated with the call via an air link to a participating MS being serviced via an S-BTS with which the physical TRX is associated. Illustrative examples of such remapping are described further below.

[0028] The numbers of S-BTS's and TRX's used in the embodiments described herein are merely illustrative examples, and in general the techniques disclosed herein can be used to provide service between any number *m* of physical BTS's using a fewer (e.g., maximum) number of *n* logical BTS's from the perspective of the BSC or other mobile network node. For example, if the BTS 106 of Figure 2 comprised a maximum of four TRX's, such that an additional eight logical timeslots were available, in the approach illustrated in Figure 4 an additional two S-BTS's and associated TRX's could be supported, to make full use of the maximum 28 TCH's. Likewise, if the BTS 106 were limited to two TRX's, eight fewer TCH timeslots would be available, such that only three S-BTS's and associated TRX's could be supported.

[0029] Figure 5 is a block diagram illustrating an embodiment of a set of base stations in which a logical TRX is to support multiple physical TRX's, each having fewer than a full (e.g., eight) number of usable timeslots. In this example, each S-BTS and associated TRX is limited to handling calls on two timeslots at a time, with the two remaining timeslots, i.e., those not available to handle call traffic (TCH) and

not used for the BCCH or PDCH (indicated by "X" marks in Figure 5), going unused. In the example shown in Figure 5, physical TRX's are assigned usable timeslots in pairs across which the usable timeslots of a single full TRX are spread, such that each comprises a "sub" TRX or "sub-TRX". For example, TRX S1 is shown as having timeslots 1 and 2 (504) available for use to handle call traffic (TCH) while TRX S2 has timeslots 3 and 4 (506) available, and so on through TRX S10. By so limiting the capacity of each S-BTS and associated TRX, a total of ten small scale base transceivers, each having a single TRX and each capable of supporting up to two traffic channels (TCH) at a time, can be provided using a single logical BTS from the perspective of the BSC.

[0030] Figure 6 is a block diagram illustrating an embodiment of a set of base stations in which a logical TRX is to support multiple physical TRX's, each having fewer than a full (e.g., eight) number of usable timeslots. In this example, each S-BTS and associated TRX is limited to handling calls on a single timeslot, with the three remaining timeslots going unused. For example, each of TRX's S1 through S4 has a single timeslot, timeslots 1-4 (602-608) respectively, available to handle call traffic (TCH). By so limiting the capacity of each S-BTS and associated TRX, a total of twenty small scale base transceivers, each having a single TRX and each capable of supporting a single traffic channel (TCH), can be provided using a single logical BTS from the perspective of the BSC.

[0031] Figure 7 is a flow chart illustrating an embodiment of a process for using a single logical BTS to provide mobile service via a plurality of physical BTS's. In some embodiments the process of Figure 7 is implemented on an aggregation node, such as AGW 302 of Figure 3. In the example shown, as outbound (i.e., from the mobile network for transmission by BTS's) BCCH and/or PDCH messages are received (702), they are forwarded to a corresponding BTS if timeslot remapping is not being performed (704, 706). If timeslot remapping is being performed (704), e.g., to enable a single logical BTS with which the received traffic is associated to be used to provide service via a plurality of physical BTS's, then the received traffic is propagate to each of a plurality of such physical BTS's (708), for transmission by each on a corresponding timeslot(s) as applicable. For example, in the example

shown in Figure 4, a received BCCH message associated at the BSC with logical timeslot 0 of BTS 106 would be propagated to each of the five S-BTS's shown in Figure 4, for transmission by each on its associated physical timeslot 0.

[0032] Figure 8 is a flow chart illustrating an embodiment of a process for using a single logical BTS to provide mobile service via a plurality of physical BTS's. In some embodiments the process of Figure 8 is implemented on an aggregation node, such as AGW 302 of Figure 3. In the example shown, when a new call is set up (802) the physical BTS (e.g., S-BTS) with which the call is associated is determined (804), for example the S-BTS via which a participating MS is being provided service; and a mapping between a logical timeslot to which the call is assigned, e.g., by the BSC, and a physical timeslot on the serving S-BTS is established (806). Subsequently received call traffic is remapped, per the mapping, as required (808), such that call traffic as seen by the BSC is associated with the assigned logical timeslot and as seen by the S-BTS is associated with the physical timeslot being used to service the call.

[0033] Figure 9 is a flow chart illustrating an embodiment of a process for handling inbound call traffic. In some embodiments, the process of Figure 9 is used to implement 808 of Figure 8 with respect to inbound call traffic, i.e., traffic received from the serving S-BTS and intended to be sent into the mobile network (e.g., PLMN) via a serving BSC. In some embodiments the process of Figure 9 is implemented on an aggregation node, such as AGW 302 of Figure 3. As inbound traffic is received from the serving S-BTS (902), the logical timeslot with which the call is associated at the BSC is determined (904) and the timeslot is remapped (906) to that logical timeslot prior to the traffic being forwarded to the BSC (908).

[0034] Figure 10 is a flow chart illustrating an embodiment of a process for handling outbound call traffic. In some embodiments, the process of Figure 10 is used to implement 808 of Figure 8 with respect to outbound call traffic, i.e., traffic received at a serving BSC, from the mobile network (e.g., PLMN), and intended to be sent to a serving S-BTS for transmission to a participating MS. In some embodiments the process of Figure 9 is implemented on an aggregation node, such as AGW 302 of Figure 3. As outbound traffic is received (1002), e.g., from the BSC, the serving S-BTS and the timeslot that is being used on that S-BTS to service the call are

determined (1004) and the traffic is remapped to that S-BTS timeslot (1006) prior to the traffic being forwarded to the serving S-BTS (1008).

[0035] Figure 11 is a block diagram illustrating an embodiment of a system for using a single logical BTS to provide mobile service via a plurality of physical BTS's. In the example shown, a single logical BTS having three logical TRX's associated with it is used to provide mobile services via a plurality of five physical small scale BTS's (1110), denoted S-BTS 1 through S-BTS 5, each having a single physical TRX associated with it. In the example shown, the BCCH on logical timeslot 0 is propagated to the respective timeslot 0 of each of the five S-BTS's and the PDCH channels on logical timeslots 13-15 are propagated to the respective timeslots 5-7 of each of the five S-BTS's. Each of the remaining four timeslots on each S-BTS are available to be mapped dynamically to a logical timeslot of the logical BTS, e.g., to provide a traffic channel (TCH) to handle call traffic. In the example shown, mobile stations MS 1 and MS 2 have calls associated at the BSC with logical timeslots 12 and 22 respectively (i.e., timeslot 4 of logical TRX 2 and timeslot 6 of logical TRX 3, respectively, see Figure 2), which logical timeslots have been remapped to timeslots 1 and 2, respectively, of TRX 1' of S-BTS 1, as shown in table 1120 and the timeslot map for TRX 1', shown below S-BTS 1. Likewise, each of mobile stations MS 3 and MS 4is participating in a call via a serving S-BTS, with the logical timeslots assigned at the BSC being mapped to corresponding S-BTS timeslots as shown in table 1120 and in the timeslot maps shown below S-BTS 5 and S-BTS 2, respectively. Finally, MS 5 and MS 6 are participating, via S-BTS 3 and S-BTS 4, respectively, in packet data communications via the packet data channels provided via logical timeslots 13, 14, and 15, propagated in this example to timeslots 5-7 of each of the S-BTS's, include S-BTS's 3 and 4 serving MS 5 and MS 6, respectively.

[0036] Figure 12 is a block diagram illustrating an embodiment of a system for using a single logical BTS to provide mobile service via a plurality of physical BTS's. In the example shown, each S-BTS is limited to using two timeslots for call traffic (TCH), enabling a total of ten S-BTS's to be supported using BSC resources associated with a single logical BTS having three logical TRX's associated with it at

the BSC. As noted above, up to twenty S-BTS's could be supported by limiting each to a single TCH timeslot.

[0037] Using frequency hopping/remapping to enable resources associated with a single logical BTS to be used to provide service via multiple physical BTS's is disclosed. In some embodiments, each of a plurality of BTS's is configured to broadcast as required on a selected one of a plurality of frequencies, each associated with a corresponding logical TRX associated at a BSC or other mobile network node with a corresponding logical BTS. Calls serviced by a physical BTS, such as an S-BTS, are provided using the physical BTS timeslot corresponding to the logical TRX timeslot to which the call has been assigned, by configuring the physical BTS to operate on that timeslot at a frequency associated with the logical TRX to which the call has been assigned, e.g., at the BSC. For example, if there are three logical TRX's associated at the BSC with a logical BTS, such as BTS 106 of Figures 1 and 2, then in some embodiments each of a plurality of physical BTS's, e.g., S-BTS's, each having a single physical TRX, would be configured to operate as required, on each of a plurality of timeslots, at a selected one of three frequencies, each associated with a corresponding logical TRX. For example, a call assigned at the BSC to a timeslot 4 of a logical TRX 2 associated with an assigned frequency f2 would be serviced by a serving S-BTS via its timeslot 4 operating at the frequency f2. Likewise, a call being serviced by the same S-BTS but assigned at the BSC to a logical timeslot 5 of a logical TRX 3 associated with an assigned frequency f3 would be serviced by the S-BTS via its timeslot 5 but at the frequency f3.

[0038] Figure 13 is a flow chart illustrating an embodiment of a process for using frequency remapping to enable a single logical BTS to be used to provide mobile services via multiple physical BTS's. In the example shown, when a call is setup (1302), the S-BTS via which the call will be provided (1304) and the transmit frequency of the logical TRX to which the call has been assigned (1306) are determined. The serving S-BTS is configured to use, on the timeslot to which the call has been assigned, the frequency associated with the logical TRX to which the call has been assigned (1308).

[0039] Figure 14 is a flow chart illustrating an embodiment of a process for handling inbound call traffic in an environment in which frequency remapping is being used to enable a single logical BTS to be used to provide mobile services via multiple physical BTS's. In the example shown, as inbound traffic is received (1402) the logical TRX with which the call is associated at the BSC is determined (1404) and the call data is forwarded to the BSC in a manner that associates the call data with the logical TRX and timeslot to which the call is assigned (1406 and 1408).

[0040] Figure 15 is a flow chart illustrating an embodiment of a process for handling outbound call traffic in an environment in which frequency remapping is being used to enable a single logical BTS to be used to provide mobile services via multiple physical BTS's. In the example shown, as outbound traffic is received (1502), it is determined which S-BTS is servicing the call (1504) and the traffic is forwarded to the serving S-BTS (1506), which transmits the traffic at a frequency associated with a logical TRX with which the call is associated at the BSC.

[0041] In some embodiments, using frequency remapping/hopping in some embodiments requires less management of call state and other data and less alteration of call traffic than the timeslot remapping approach described above.

[0042] Although the foregoing embodiments have been described in some detail for purposes of clarity of understanding, the invention is not limited to the details provided. There are many alternative ways of implementing the invention. The disclosed embodiments are illustrative and not restrictive.

[0043] WHAT IS CLAIMED IS:

CLAIMS

1. A method of providing mobile telecommunication service, comprising:

receiving a call traffic associated with a call associated at a mobile network with an assigned timeslot of a logical base transceiver; and

remapping a timeslot with which the call traffic is associated from the assigned timeslot to a serving timeslot being used at a serving physical base transceiver to facilitate the call, in the event the call traffic comprises inbound call traffic being sent into the mobile network from the serving physical base transceiver, or from the serving timeslot to the assigned timeslot in the event the call traffic comprises outbound call traffic being sent from the mobile network to the serving physical base transceiver.

2. A method as recited in claim 1, wherein the logical base transceiver comprises a logical base transceiver station (BTS).

3. A method as recited in claim 1, wherein the call traffic comprises inbound call traffic received from the serving physical base transceiver via an IP network.

4. A method as recited in claim 3, wherein the call traffic is received at an aggregation gateway (AGW).

5. A method as recited in claim 1, wherein the serving physical base transceiver comprises a small scale base transceiver station (S-BTS).

6. A method as recited in claim 5, wherein the S-BTS is deployed to one or more of the following: a residence, a business, and a geographically remote or isolated area.

7. A method as recited in claim 1, further comprising receiving an indication that the call is being set up and assigned to the assigned timeslot.

8. A method as recited in claim 7, further comprising storing a mapping data that associates the assigned timeslot with the serving timeslot.

9. A method as recited in claim 8, wherein the mapping data is used to remap the timeslot.

10. A method as recited in claim 1, wherein remapping the timeslot comprises altering a timeslot identifier data included in the call traffic.

11. A method as recited in claim 1, further comprising propagating to a corresponding timeslot of each of a plurality if physical base transceivers a broadcast control channel (BCCH) message associated with a broadcast control channel of the logical base transceiver.

12. A method as recited in claim 1, further comprising propagating to a corresponding timeslot of each of a plurality if physical base transceivers a packet data channel (PDCH) message associated with a packet data channel of the logical base transceiver.

13. A mobile telecommunication system, comprising:

a communication interface configured to receive a call traffic associated with a call associated at a mobile network with an assigned timeslot of a logical base transceiver; and

a processor coupled to the communication interface and configured to remap a timeslot with which the call traffic is associated from the assigned timeslot to a serving timeslot being used at a serving physical base transceiver to facilitate the call, in the event the call traffic comprises inbound call traffic being sent into the mobile network from the serving physical base transceiver, or from the serving timeslot to the assigned timeslot in the event the call traffic comprises outbound call traffic being sent from the mobile network to the serving physical base transceiver.

14. A mobile telecommunication system as recited in claim 13, wherein the mobile telecommunication system comprises an aggregation gateway configured to communicate via an IP network with a plurality of physical base transceivers.

15. A mobile telecommunication system as recited in claim 13, wherein the processor is further configured to forward the call traffic, subsequent to remapping the timeslot, to a base station controller (BSC) in the case of inbound call traffic or to the serving physical base transceiver in the case of outbound call traffic.

16. A computer program product for providing mobile telecommunication service, the computer program product being embodied in a computer readable medium and comprising computer instructions for:

receiving a call traffic associated with a call associated at a mobile network with an assigned timeslot of a logical base transceiver; and

remapping a timeslot with which the call traffic is associated from the assigned timeslot to a serving timeslot being used at a serving physical base transceiver to facilitate the call, in the event the call traffic comprises inbound call traffic being sent into the mobile network from the serving physical base transceiver, or from the serving timeslot to the assigned timeslot in the event the call traffic comprises outbound call traffic being sent from the mobile network to the serving physical base transceiver.

17. A method of providing mobile telecommunication service, comprising:

receiving an indication that a call to be provided via a serving physical base transceiver is associated at a mobile network with an assigned timeslot of a logical base transceiver; and

configuring the serving physical base transceiver to operate with respect to a serving timeslot of the serving physical base transceiver, which serving timeslot corresponds to the assigned timeslot of the logical base transceiver, at a selected one of a plurality of frequencies at which the serving physical base transceiver is configured to operate with respect to the serving timeslot, the selected frequency corresponding to an assigned frequency associated at the mobile network with the logical base transceiver.

18. A method as recited in claim 17, wherein the logical base transceiver comprises one of a plurality of logical transceivers (TRX) associated at the mobile network with a logical base transceiver station (BTS), each such logical transceiver is associated at the mobile network with a corresponding one of the plurality of frequencies, and the serving physical base transceiver comprises one of a plurality of physical base transceiver stations that the logical base transceiver station is being used to support.

19. A method as recited in claim 18, wherein each of said physical base transceiver stations comprises a physical base transceiver (TRX) configured to operate as required, one each of a plurality of physical base transceiver timeslots, at a selected one of the plurality of frequencies.

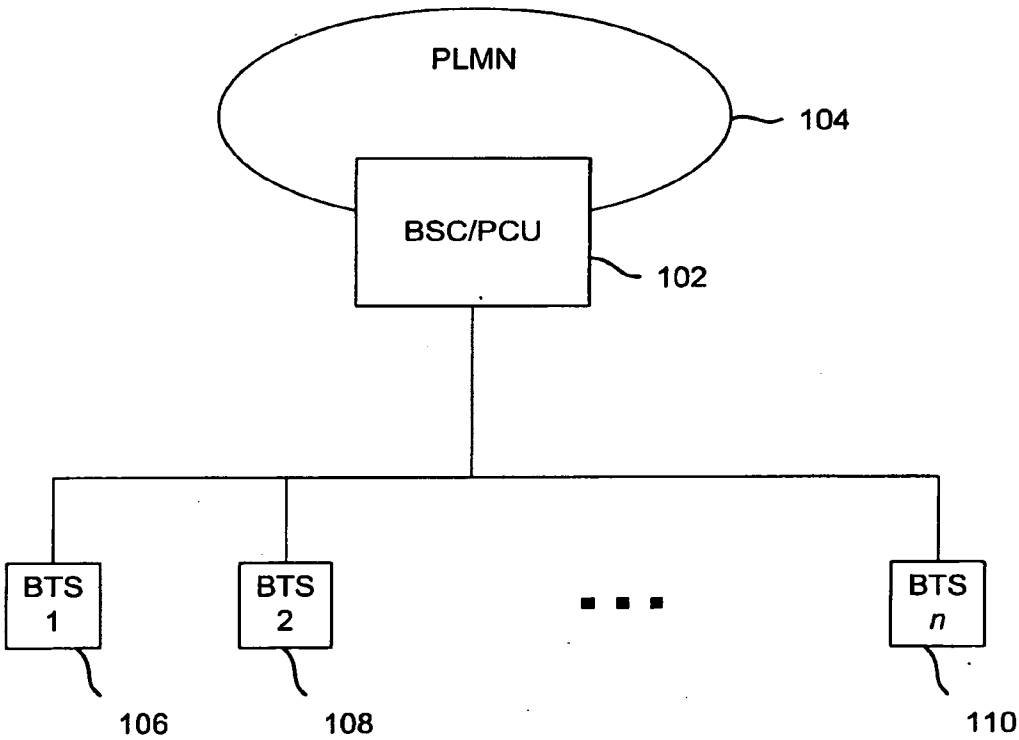


FIG. 1

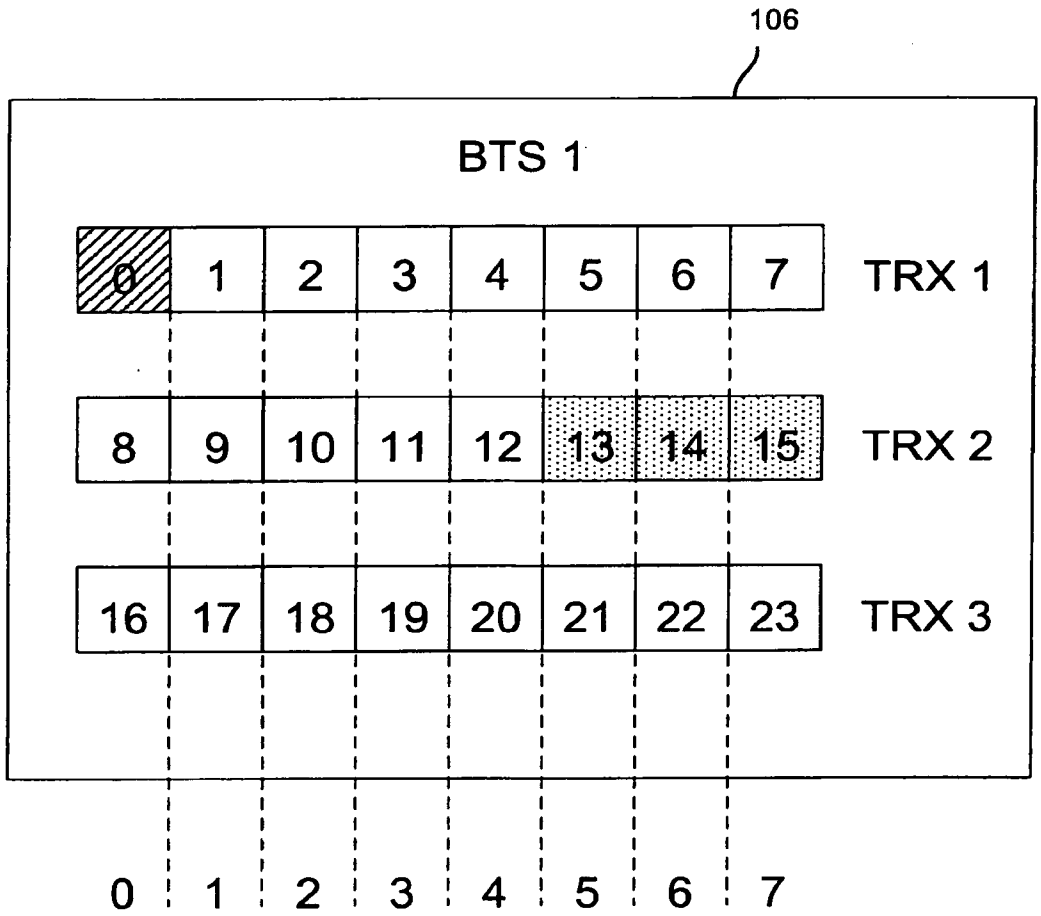

106
BTS 1
0
1
2
3
4
5
6
7
TRX 1
8
9
10
11
12
13
14
15
TRX 2
16
17
18
19
20
21
22
23
TRX 3
0
1
2
3
4
5
6
7

FIG. 2

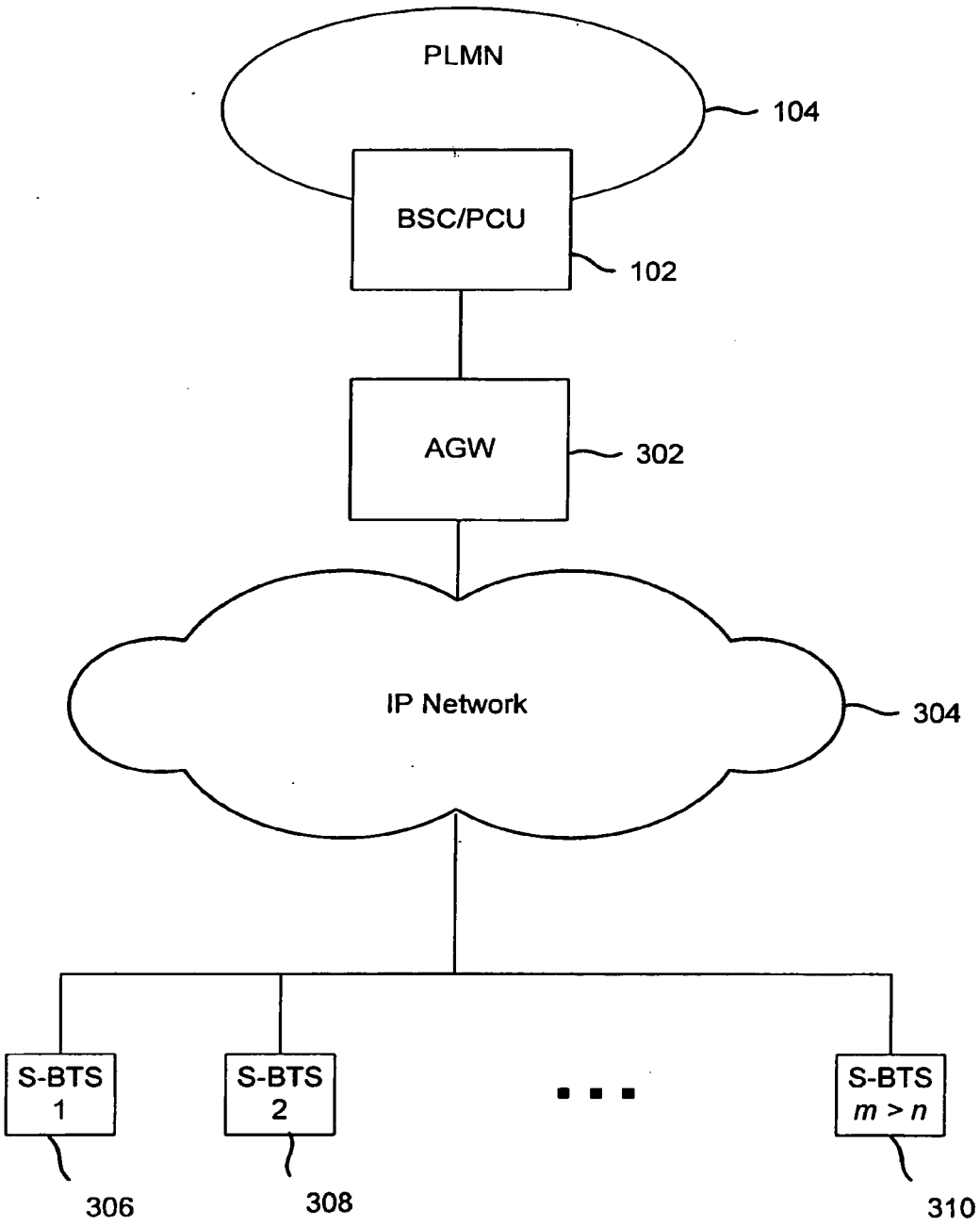

PLMN
104
BSC/PCU
102
AGW
302
IP Network
304
S-BTS 1
S-BTS 2
S-BTS m > n
306
308
310

FIG. 3

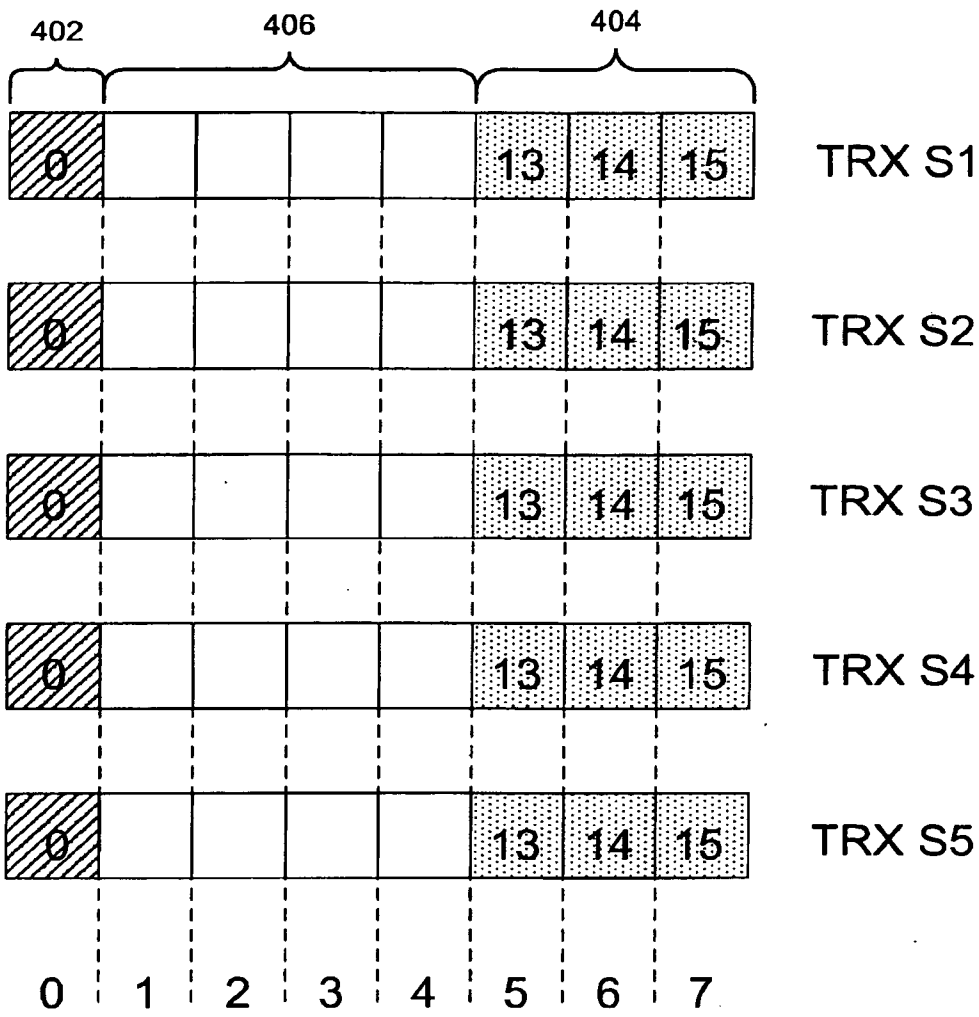


FIG. 4

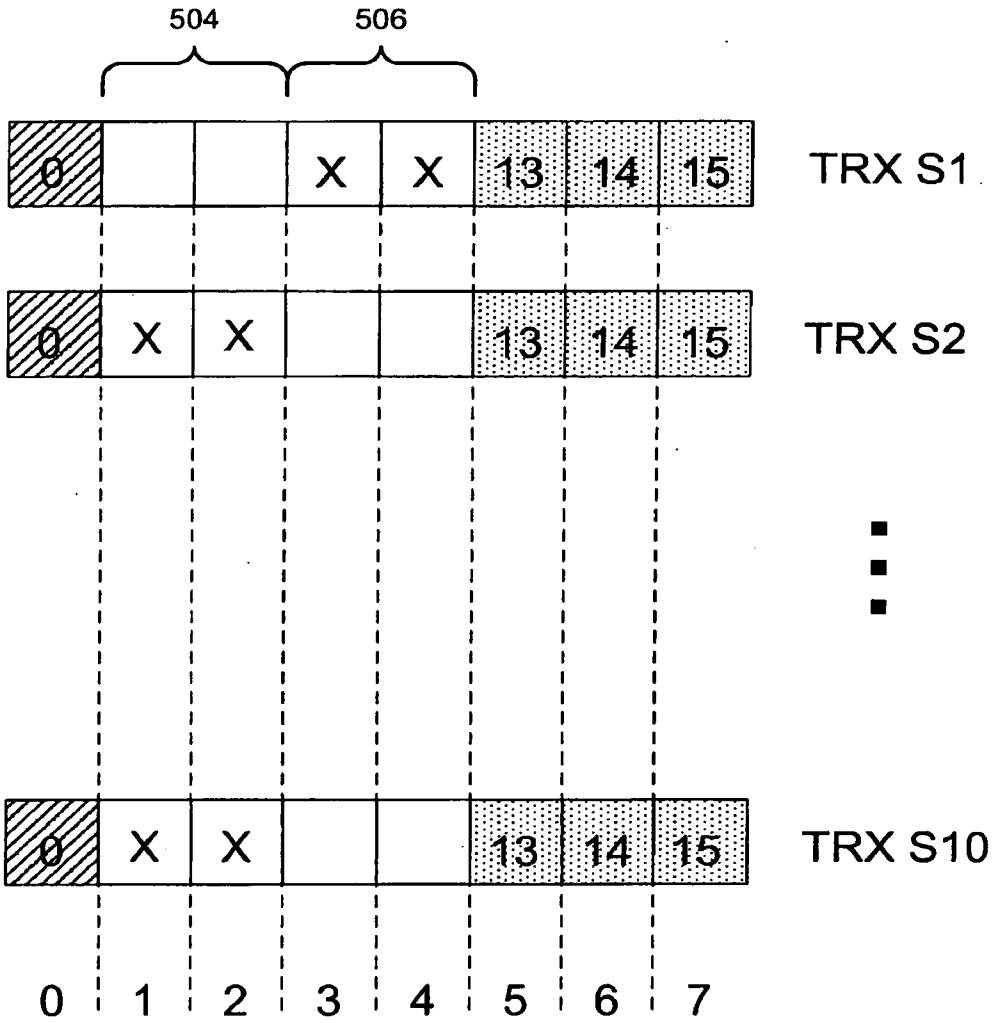

504
506
0
X
X
13
14
15
TRX S1
0
X
X
13
14
15
TRX S2
0
X
X
13
14
15
TRX S10
0
1
2
3
4
5
6
7

FIG. 5

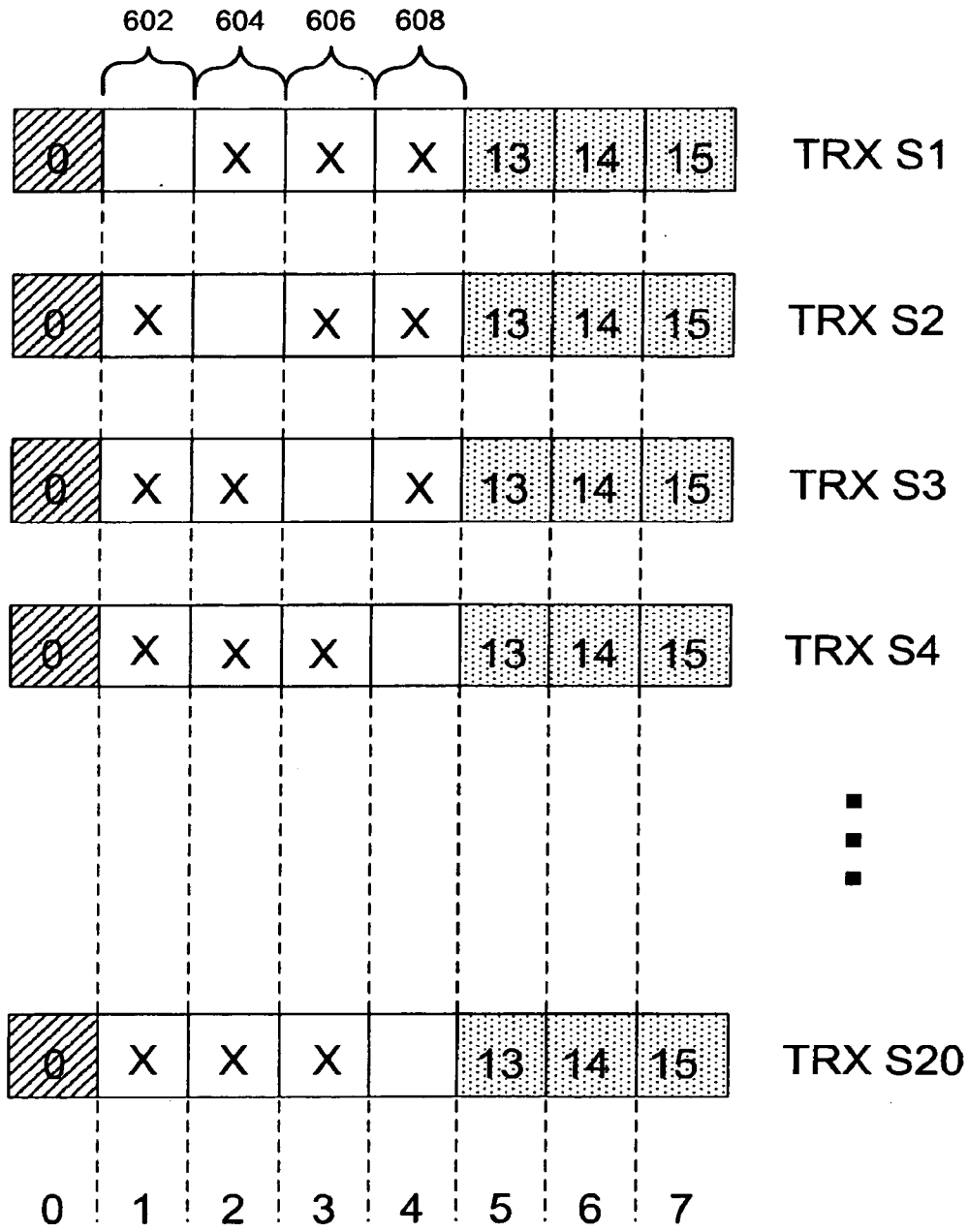

602
604
606
608
0
X
X
X
13
14
15
TRX S1
TRX S2
TRX S3
TRX S4
TRX S20
0
1
2
3
4
5
6
7

FIG. 6

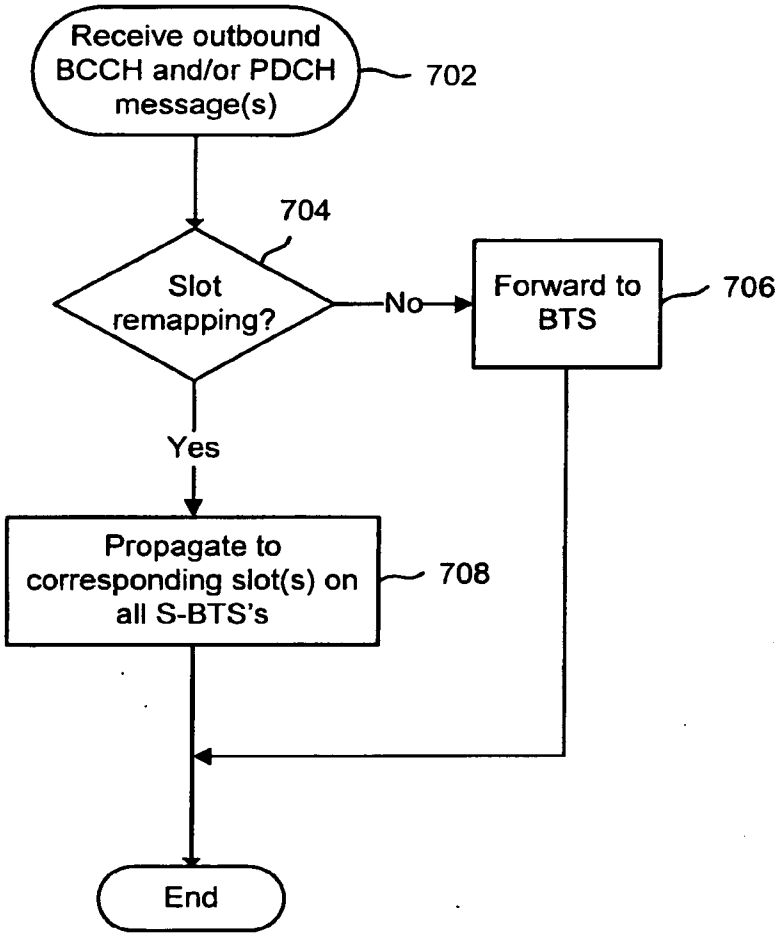

Receive outbound BCCH and/or PDCH message(s)
702
704
Slot remapping?
No
Forward to BTS
706
Yes
Propagate to corresponding slot(s) on all S-BTS's
708
End

FIG. 7

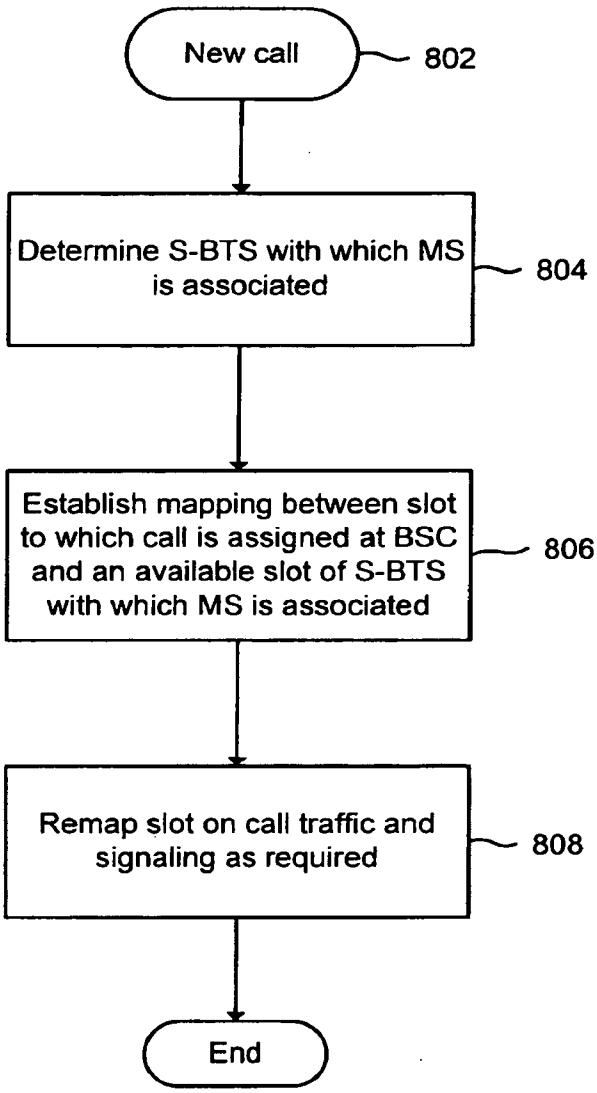

New call
802
Determine S-BTS with which MS is associated
804
Establish mapping between slot to which call is assigned at BSC and an available slot of S-BTS with which MS is associated
806
Remap slot on call traffic and signaling as required
808
End

FIG. 8

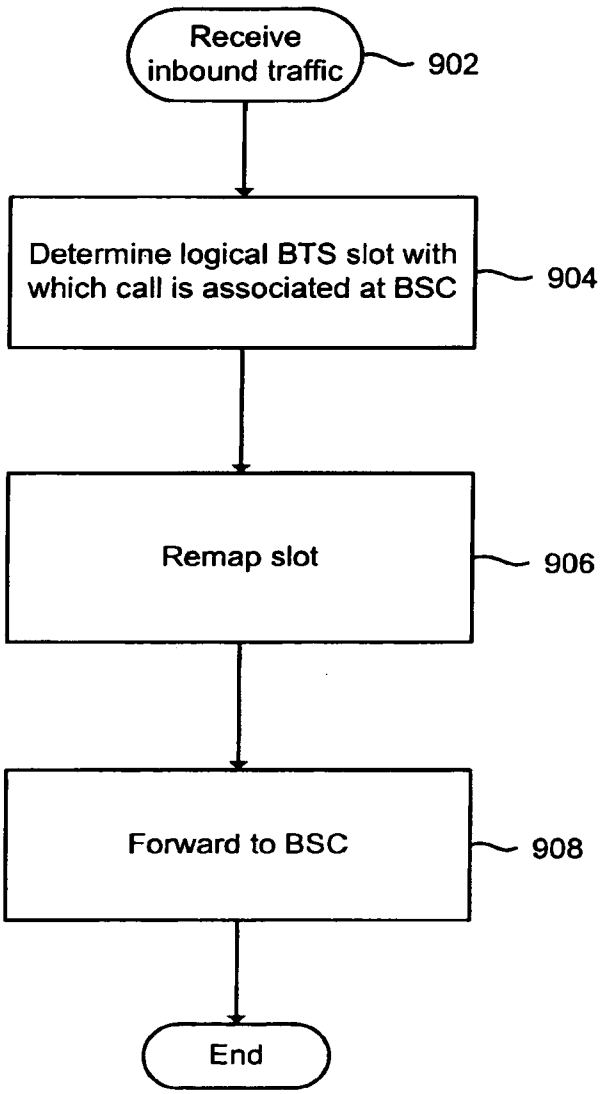

Receive inbound traffic
902
Determine logical BTS slot with which call is associated at BSC
904
Remap slot
906
Forward to BSC
908
End

FIG. 9

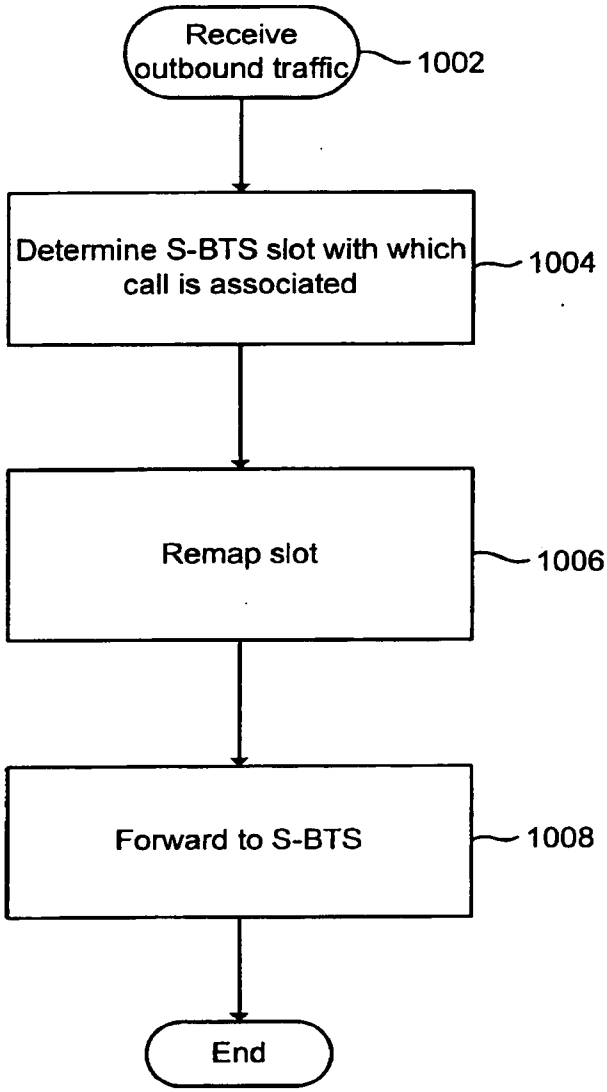
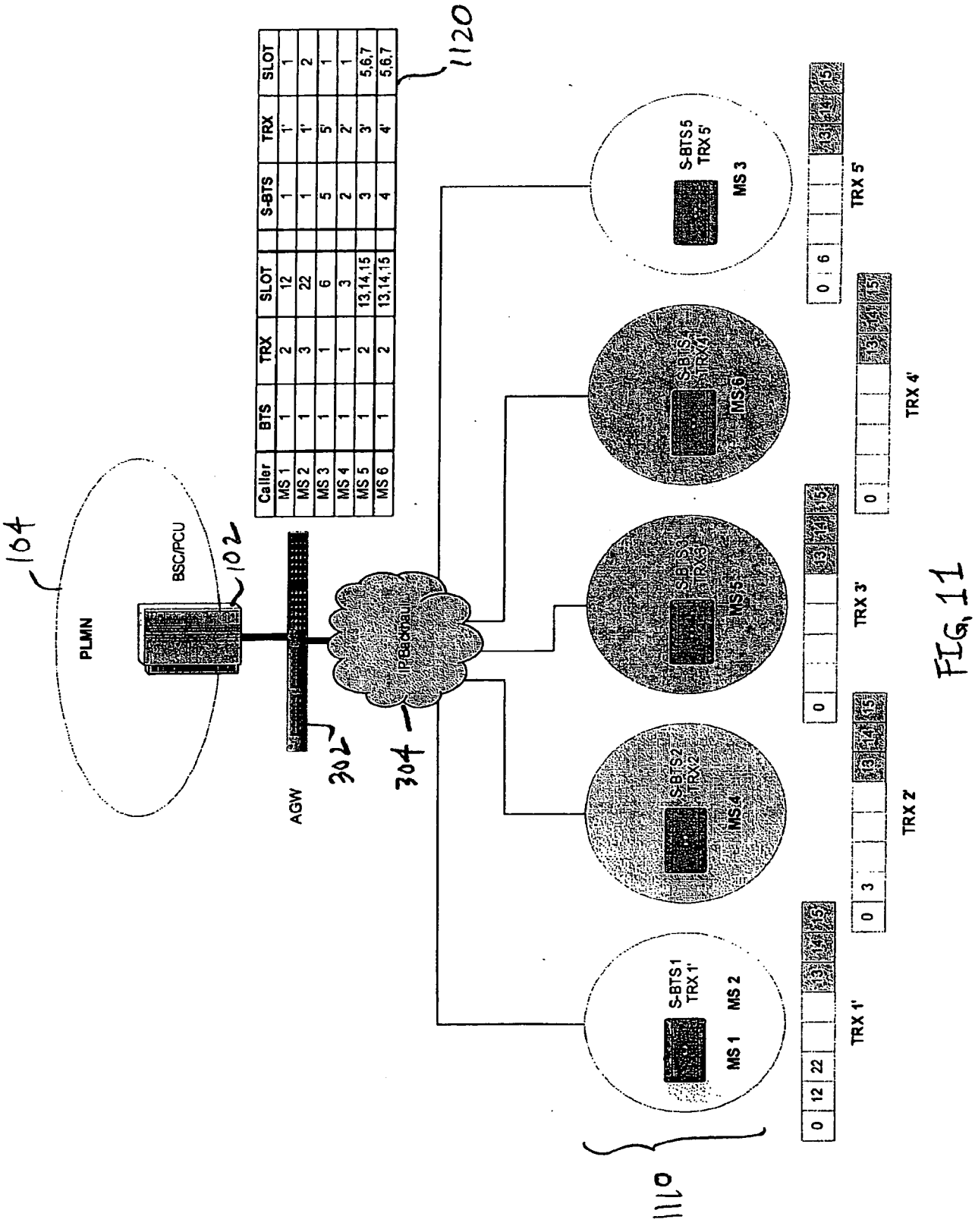

Receive outbound traffic
1002
Determine S-BTS slot with which call is associated
1004
Remap slot
1006
Forward to S-BTS
1008
End

FIG. 10



Caller	BTS	TRX	SLOT	S-BTS	TRX	SLOT
MS 1	1	2	12	1	1'	1
MS 2	1	3	22	1	1'	2
MS 3	1	1	6	5	5'	1
MS 4	1	1	3	2	2'	1
MS 5	1	2	13,14,15	3	3'	5,6,7
MS 6	1	2	13,14,15	4	4'	5,6,7

FIG. 11

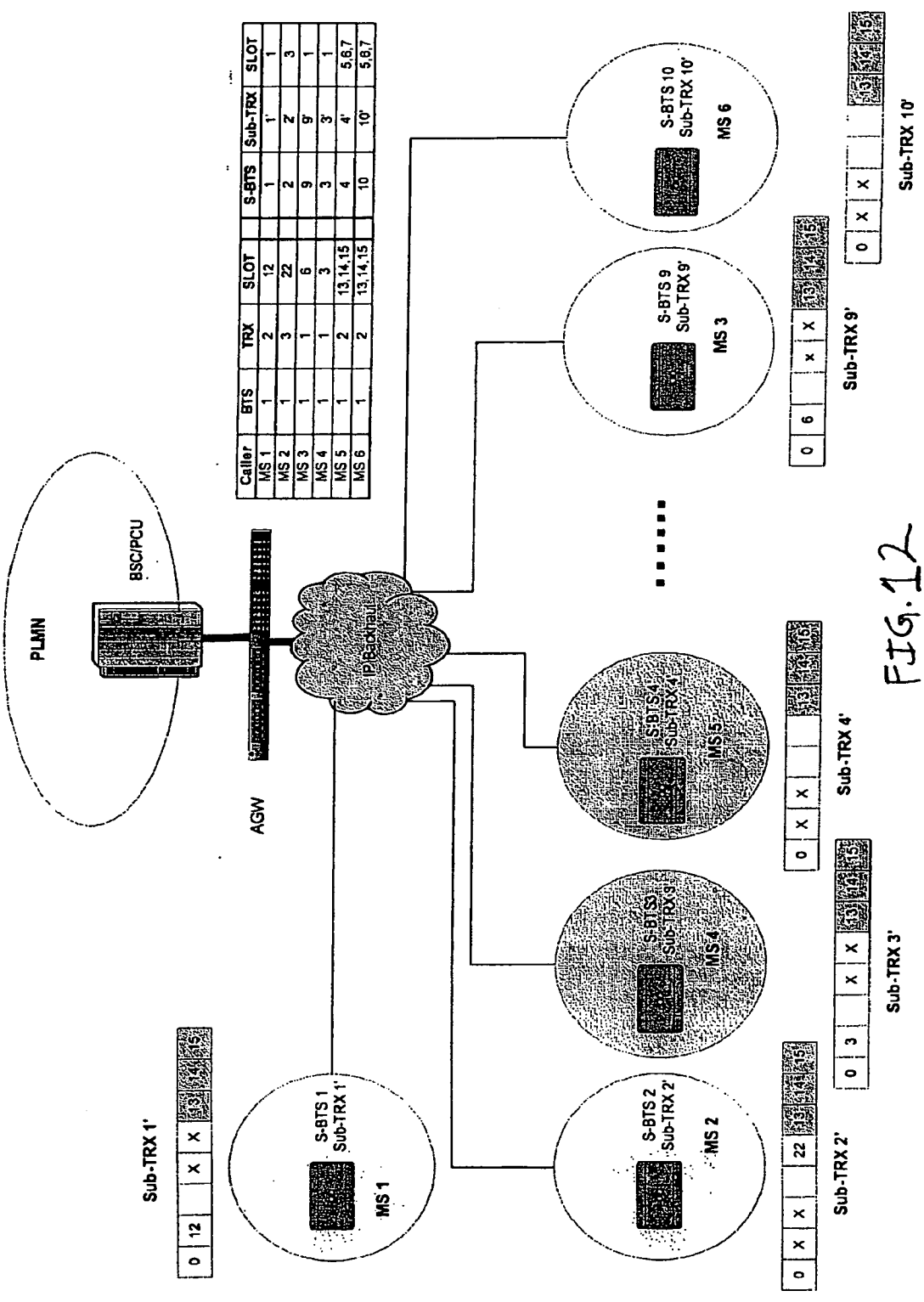

PLMN
BSC/PCU
AGW
IP Backhaul
S-BTS 1
Sub-TRX 1'
MS 1
S-BTS 2
Sub-TRX 2'
MS 2
S-BTS 3
Sub-TRX 3'
MS 4
S-BTS 4
Sub-TRX 4'
MS 5
S-BTS 9
Sub-TRX 9'
MS 3
S-BTS 10
Sub-TRX 10'
MS 6
Caller | BTS | TRX | SLOT | S-BTS | Sub-TRX | SLOT
MS 1 | 1 | 2 | 12 | 1 | 1' | 1
MS 2 | 1 | 3 | 22 | 2 | 2' | 3
MS 3 | 1 | 1 | 6 | 9 | 9' | 1
MS 4 | 1 | 1 | 3 | 3 | 3' | 1
MS 5 | 1 | 2 | 13,14,15 | 4 | 4' | 5,6,7
MS 6 | 1 | 2 | 13,14,15 | 10 | 10' | 5,6,7

FIG. 12

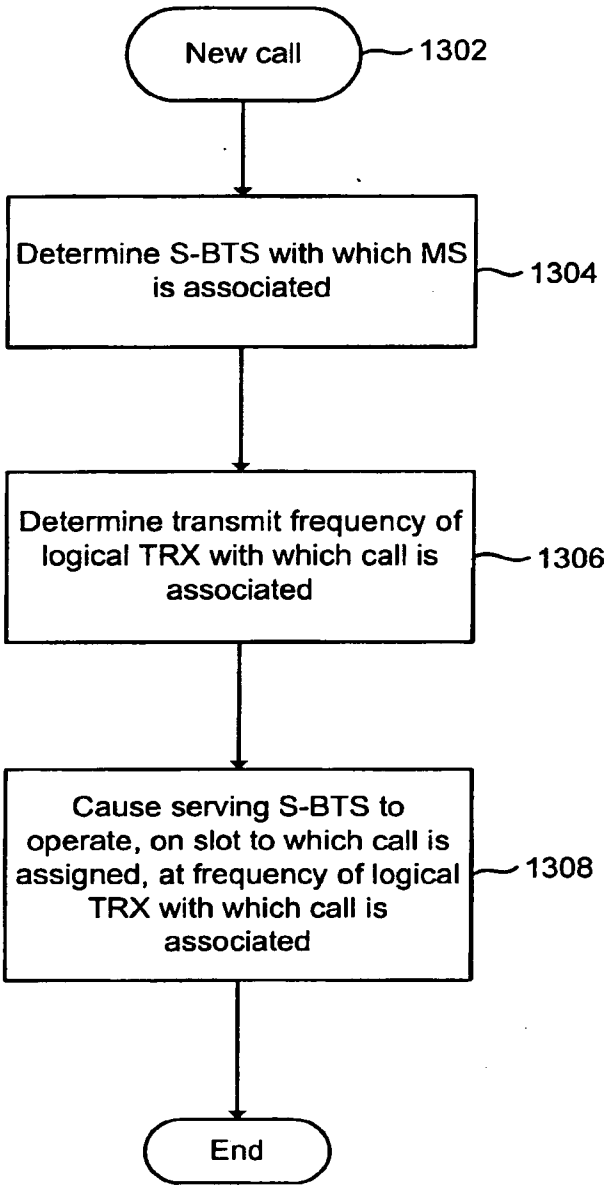

New call
1302
Determine S-BTS with which MS is associated
1304
Determine transmit frequency of logical TRX with which call is associated
1306
Cause serving S-BTS to operate, on slot to which call is assigned, at frequency of logical TRX with which call is associated
1308
End

FIG. 13

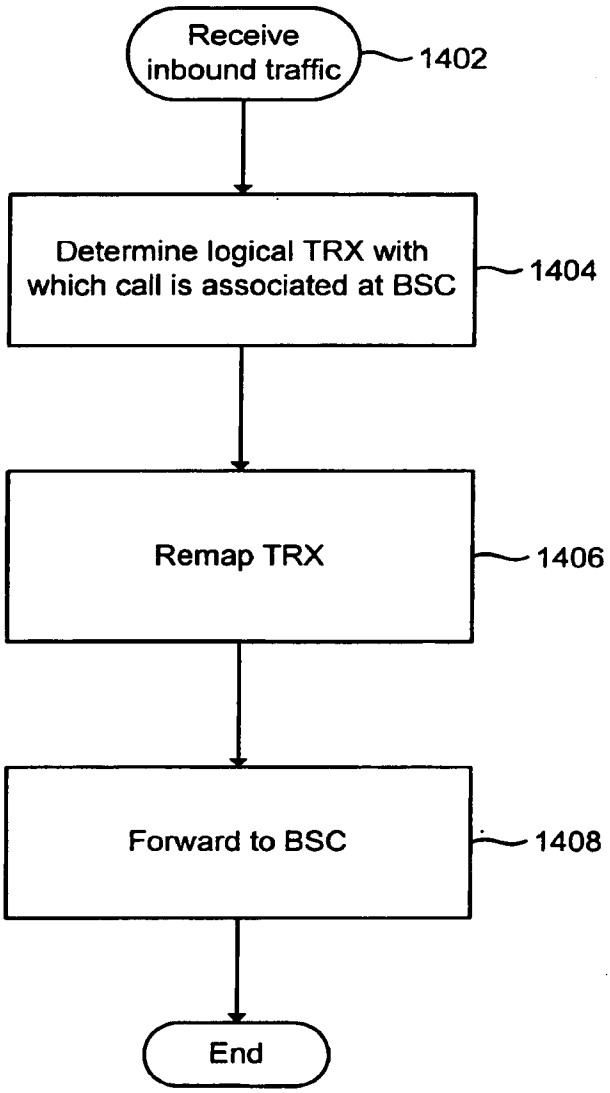

Receive inbound traffic
1402
Determine logical TRX with which call is associated at BSC
1404
Remap TRX
1406
Forward to BSC
1408
End

FIG. 14

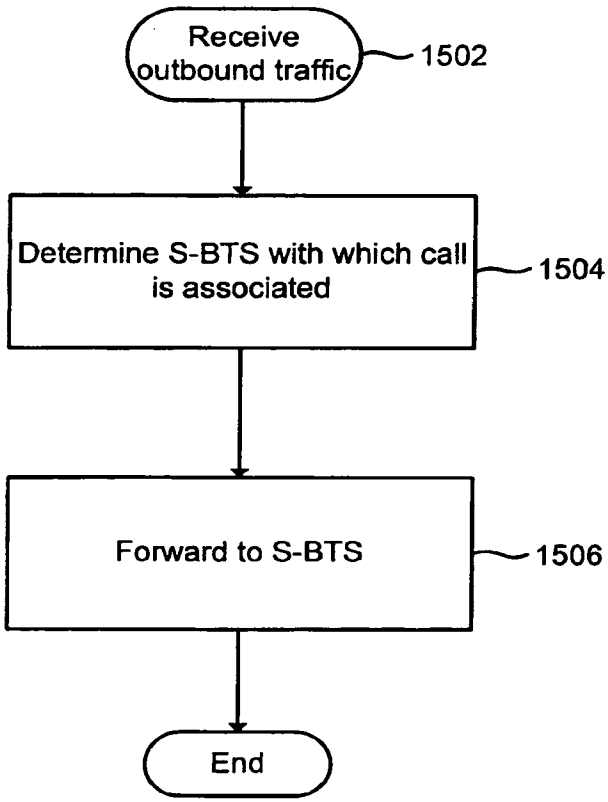

Receive outbound traffic
1502
Determine S-BTS with which call is associated
1504
Forward to S-BTS
1506
End

FIG. 15