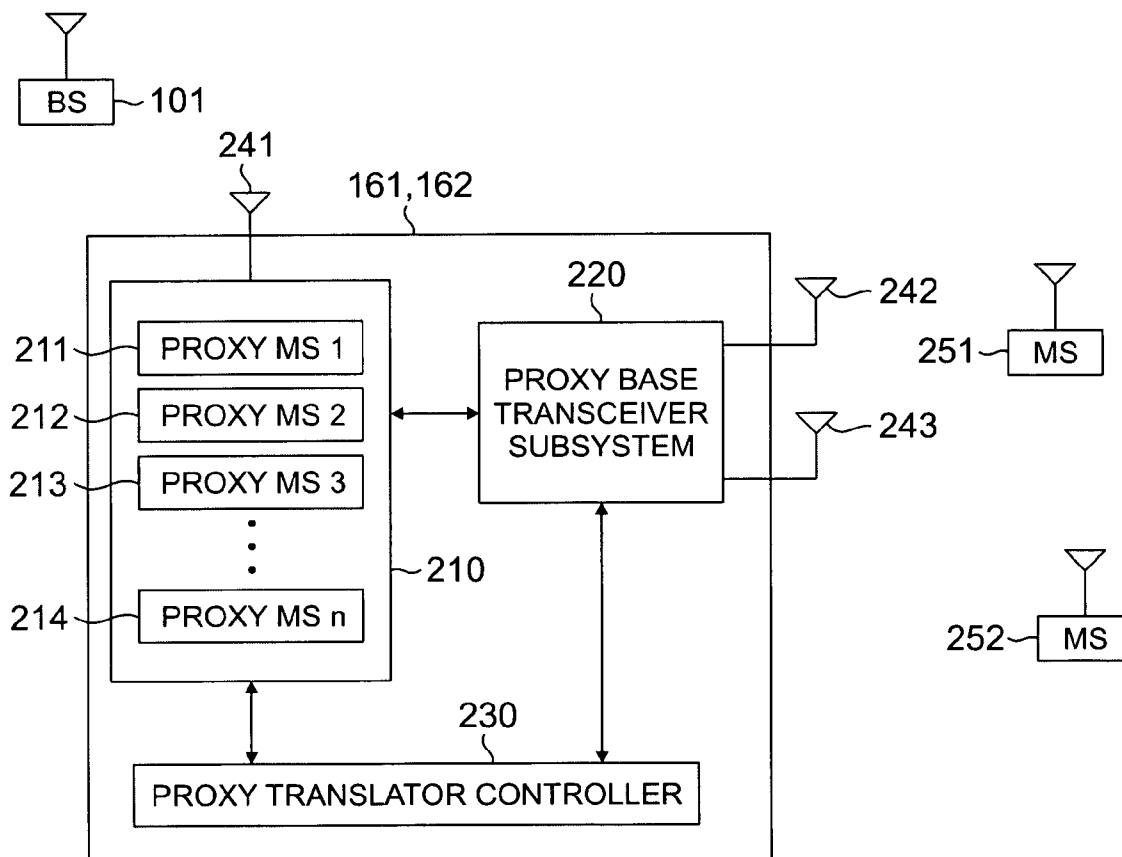




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Parikh et al.(10) **Pub. No.: US 2006/0046647 A1**(43) **Pub. Date: Mar. 2, 2006**(54) **PROXY MOBILE STATION USING
ASSIGNABLE MOBILE IDENTIFIER TO
ACCESS A WIRELESS NETWORK**(75) Inventors: **Deepak R. Parikh**, Plano, TX (US);
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H04B 7/15 (2006.01)
(52) **U.S. Cl.** **455/11.1; 455/7**(57) **ABSTRACT**

A proxy mobile station for retransmitting reverse channel signals from a mobile station to a base station of a wireless network. The proxy mobile station comprises: 1) a controller for receiving reverse channel data to be transmitted to the base station and transmitting the reverse channel data using an assigned mobile station identifier associated with the mobile station; and 2) a radio frequency transceiver for up-converting the encoded reverse channel data for transmission to the base station. The assigned mobile station is modifiable and may be modified by an external control device.



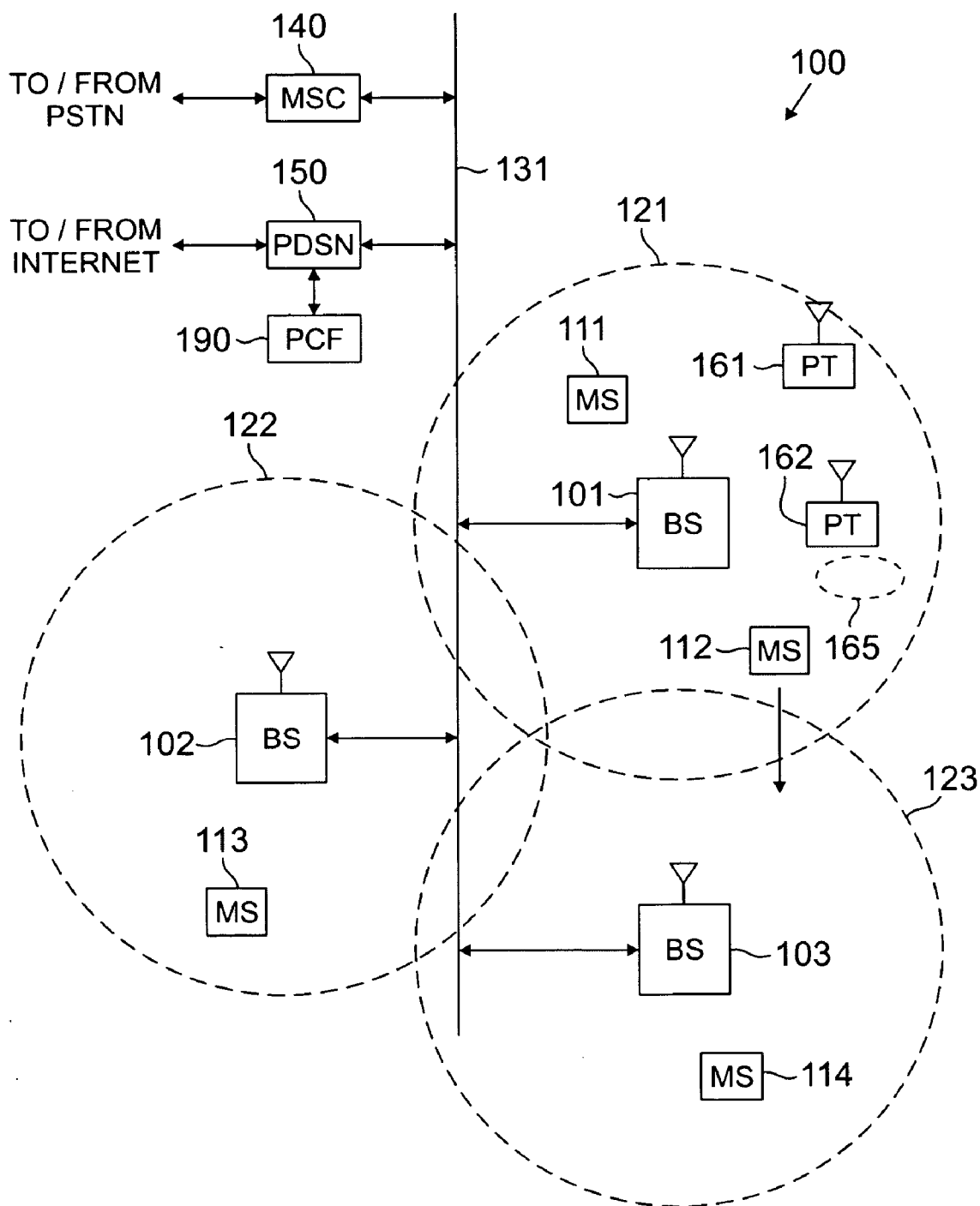


FIG. 1

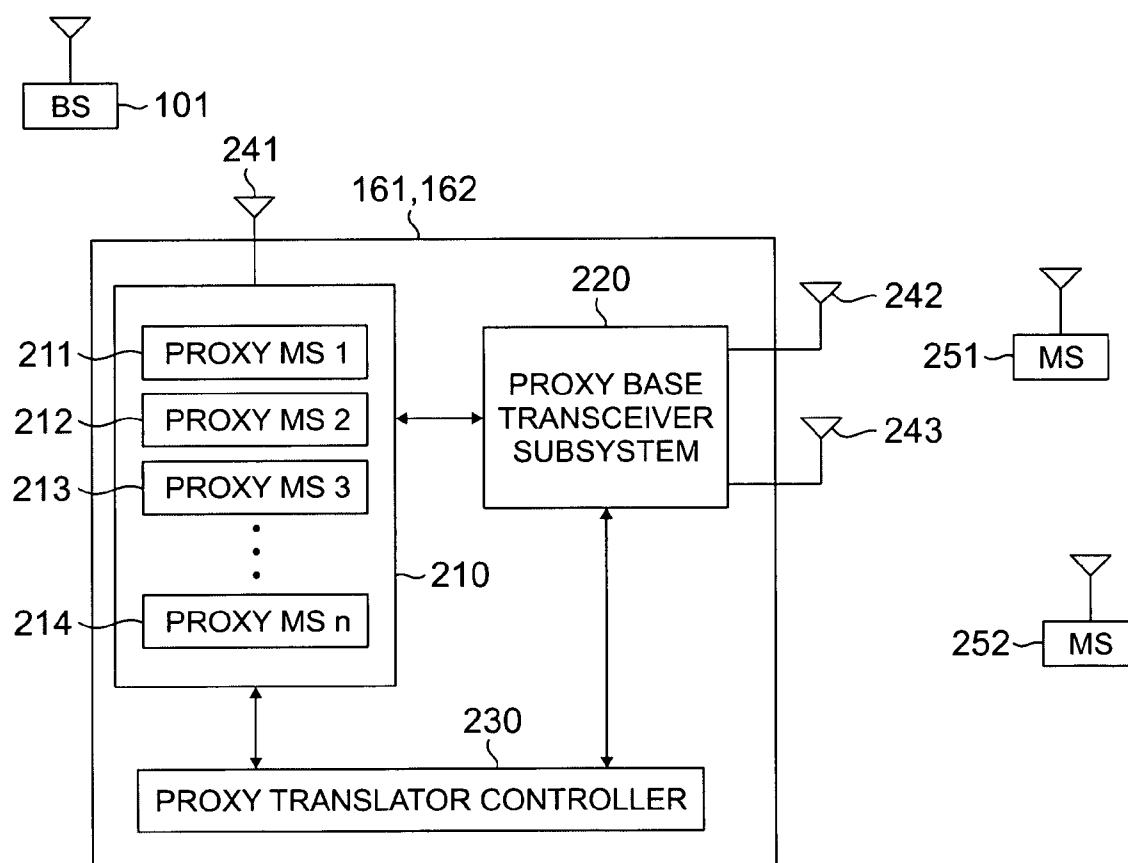


FIG. 2

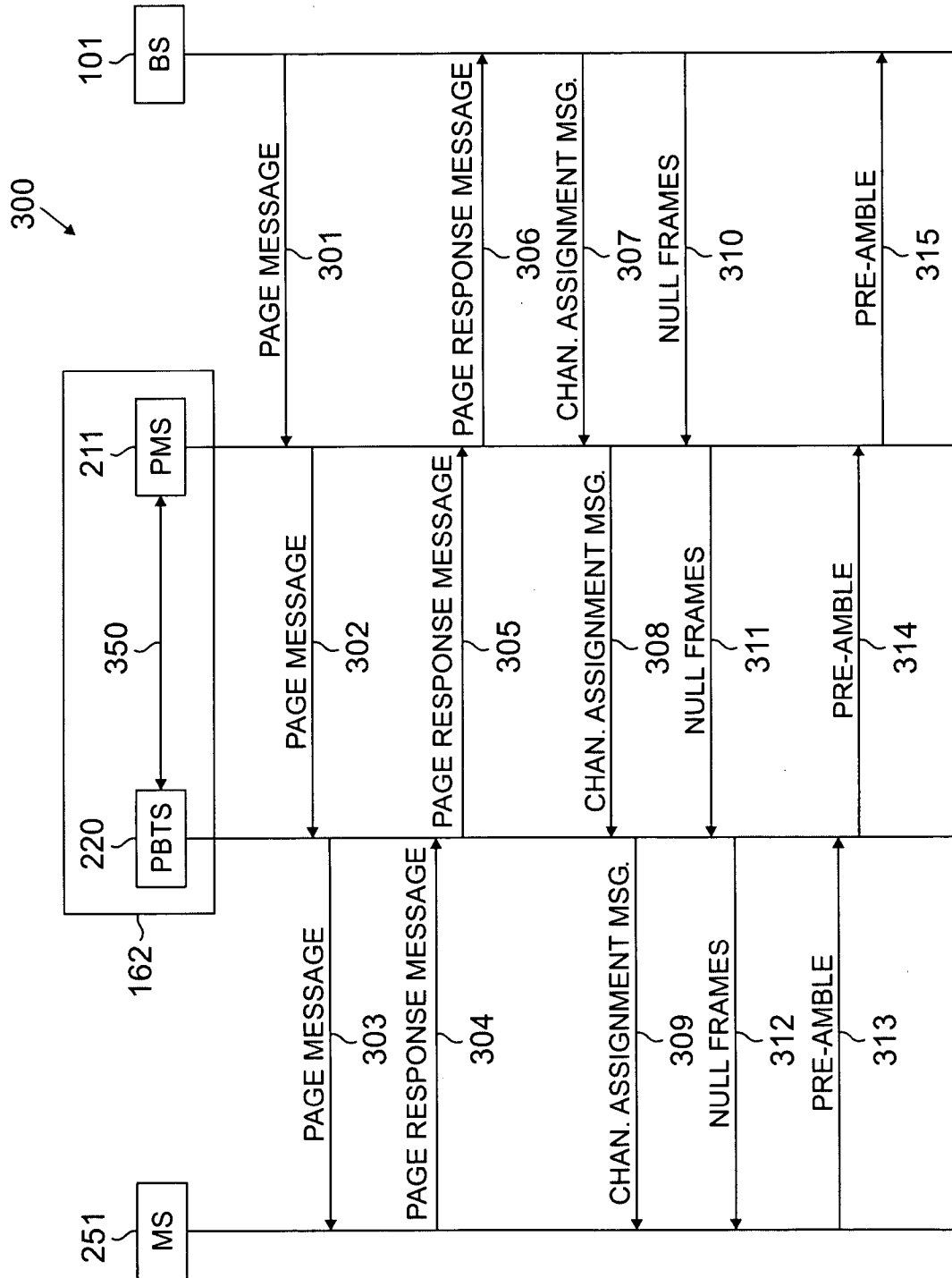


FIG. 3

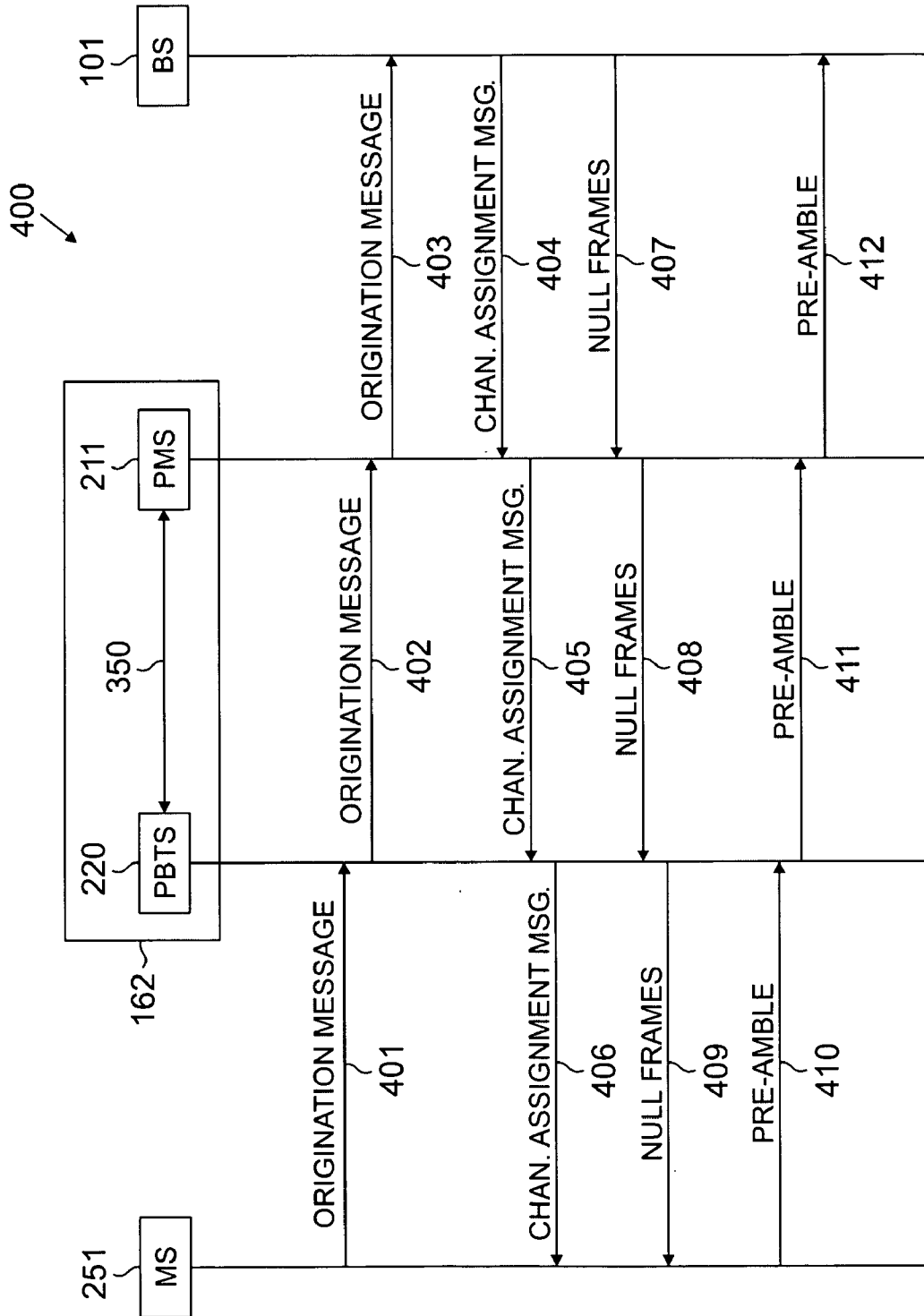


FIG. 4

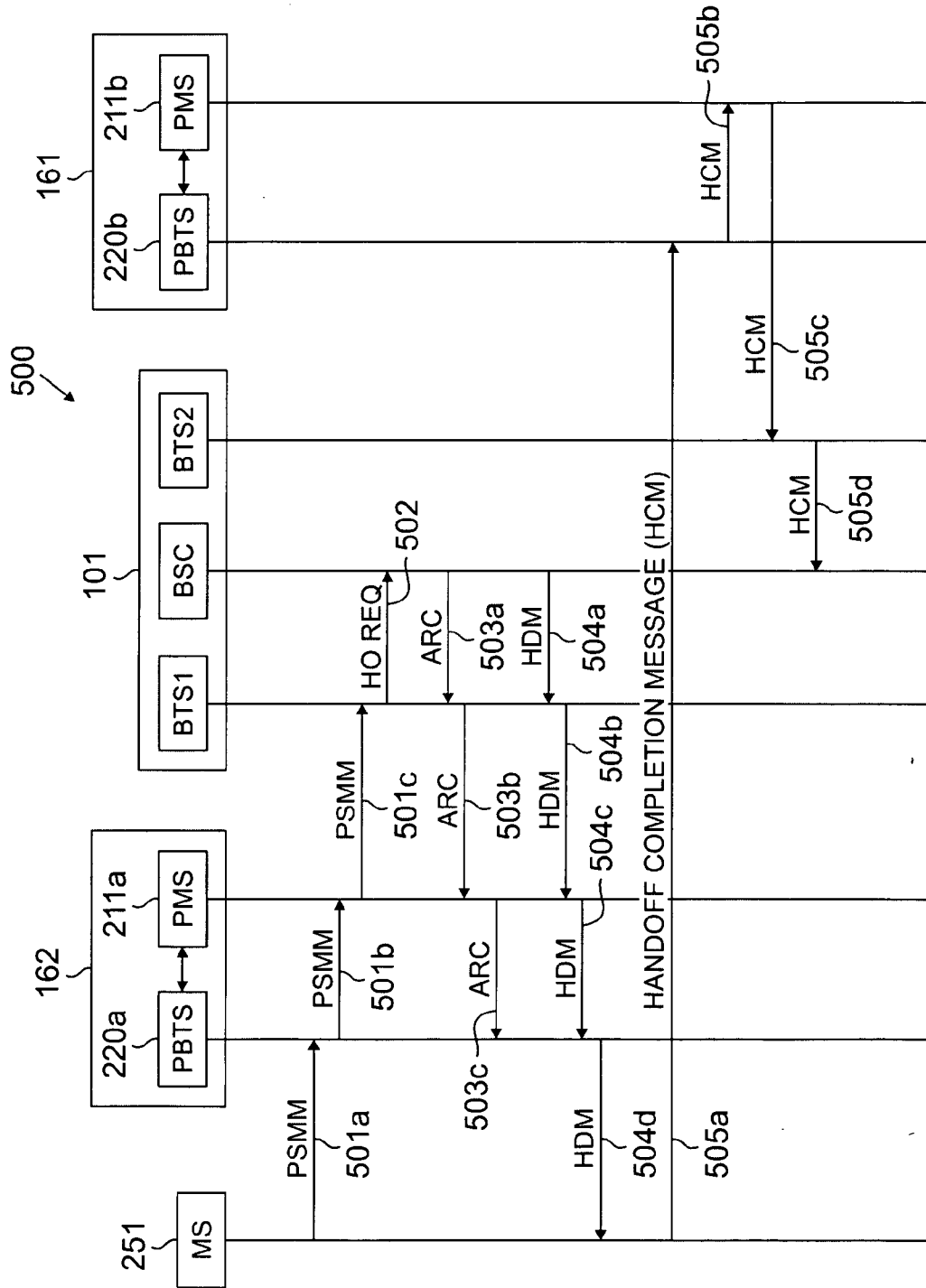


FIG. 5

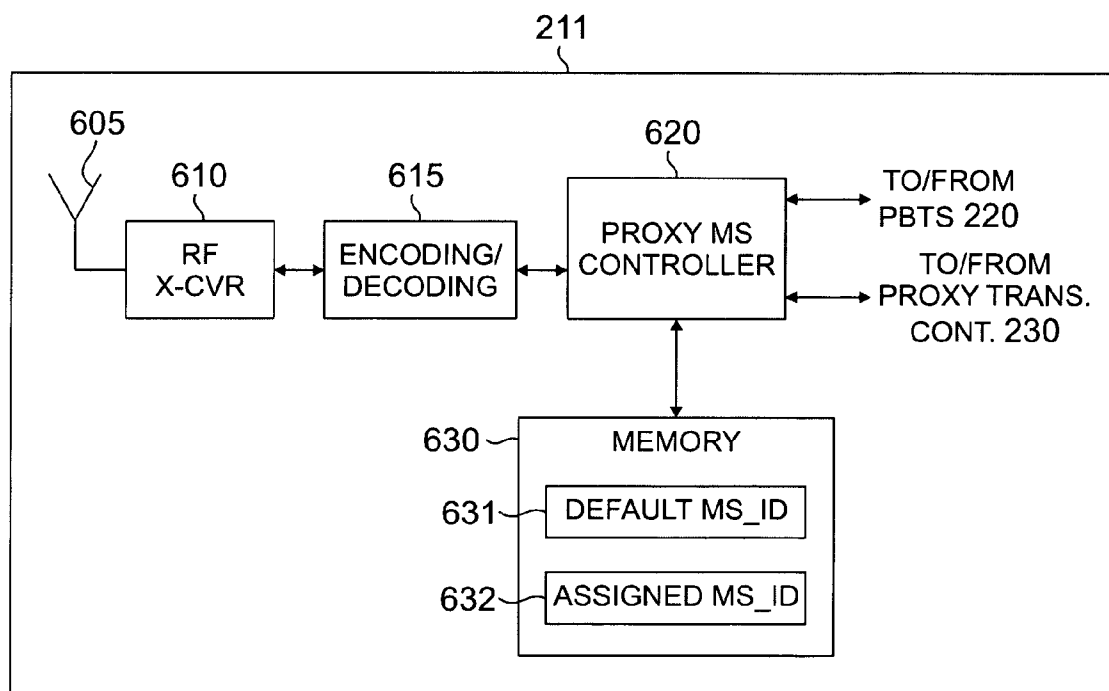


FIG. 6

PROXY MOBILE STATION USING ASSIGNABLE MOBILE IDENTIFIER TO ACCESS A WIRELESS NETWORK

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present invention is related to the invention disclosed in U.S. patent application Ser. No. _____ [Docket No. 2003.11.023.WS0], entitled "Proxy Translator For Extending The Coverage Area Of A Wireless Network" and filed concurrently herewith. U.S. patent application Ser. No. _____ [Docket No. 2003.11.023.WS0] is assigned to the assignee of the present application. The subject matter disclosed in U.S. patent application Ser. No. _____ [Docket No. 2003.11.023.WS0] is hereby incorporated by reference into the present disclosure as if fully set forth herein.

TECHNICAL FIELD OF THE INVENTION

[0002] The present invention generally relates to wireless communications and, more specifically, to a proxy device for imitating the operation of another wireless terminal in a wireless network.

BACKGROUND OF THE INVENTION

[0003] A wireless terminal accesses a wireless network using a mobile station identifier that is unique to the wireless terminal. Mobile station identifiers are used in a number of wireless networks, including wireless networks operating under the CDMA2000 family of standards, GSM networks, AMPS/TDMA networks, Wideband CDMA (or WCDMA) networks, IEEE802.xx networks, and GSM-1x networks, among others. The mobile station identifier may comprise a conventional identifier, such as an Electronic Serial Number (ESN), a User Identity Module (UIM) ID, a Subscriber Identity Module (SIM) ID, or a Mobile Equipment Identifier (MEID), or the like.

[0004] In conventional wireless technology, there is no way to dynamically assign a mobile station identifier (MS_ID) to a mobile station or other wireless terminal during actual operation in a wireless network. For security reasons, the mobile station identifier is set for each device and cannot be changed without special programming and equipment. A wireless service provider uses a mobile station identifier to identify a subscriber mobile station (e.g., cell phone, wireless laptop or PDA) in order to charge the account of each subscriber for service. However, there are applications in which it may be advantageous to assign the mobile identifier of a mobile station at least temporarily to a proxy device.

[0005] Therefore, there is a need in the art for a proxy mobile station that imitates the signals of another mobile station. In particular, there is a need for a proxy mobile station that may be assigned the mobile station identifier of another mobile station. More particularly, there is a need for a proxy mobile station that may be dynamically assigned and re-assigned the mobile station identifiers of other mobile stations.

SUMMARY OF THE INVENTION

[0006] The present invention provides an apparatus and a method by which the secure identifier (e.g., Electronic Serial Number, IP address, or the like) of a commercial mobile

station (or other wireless terminal) may be dynamically assigned to another proxy device. The proxy device (or proxy mobile station) mimics the mobile identifier of any commercial wireless access terminal (e.g., cell phone, wireless PDA or laptop, etc.) in the same class of wireless devices. Since the mobile identifier is assignable and modifiable, the proxy mobile station may be dynamically re-assigned from one wireless access terminal to another, as needed.

[0007] A proxy mobile station according to the principles of the present invention may be used advantageously in a number of applications, including a repeater that provides access to a wireless network to a mobile station that cannot access the wireless network directly. In one particularly advantageous embodiment, a proxy mobile station using an assignable mobile identifier may be used in a proxy translator device that extends the RF coverage of a wireless network. One such proxy translator is disclosed in U.S. patent application Ser. No. _____ [Docket No. 2003.11.023.WS0], incorporated by reference above.

[0008] The present invention is applicable in all wireless technologies in which a wireless terminal mobile uses a unique electronic identification number to access a wireless network or another wireless device. Examples of wireless networks include wireless network operating under the CDMA2000 family of standards, GSM networks, AMPS/TDMA networks, Wideband CDMA (or WCDMA) network, IEEE802.xx networks, and GSM-1x networks, among others. The electronic identifiers or mobile station identifiers may include fixed (32 bits, 64 bits) or variable length identifiers which uniquely describe the wireless terminal or mobile station. The mobile identifiers may be ESN, UIM (User Identity Module) ID, SIM (Subscriber Identity Module) ID, Mobile Equipment Identifier (MEID), or any other electronic identifier.

[0009] Accordingly, to address the above-discussed deficiencies of the prior art, it is a primary object of the present invention to provide, for use in a wireless network, a proxy mobile station capable of retransmitting reverse channel signals from a mobile station to a base station of the wireless network. According to an advantageous embodiment of the present invention, the proxy mobile station comprises: 1) a controller capable of receiving reverse channel data to be transmitted to the base station and transmitting the reverse channel data using an assigned mobile station identifier associated with the mobile station; and 2) a radio frequency transceiver capable of up-converting the encoded reverse channel data for transmission to the base station.

[0010] According to one embodiment of the present invention, the controller encodes the reverse channel data using the assigned mobile station identifier.

[0011] According to another embodiment of the present invention, the assigned mobile station identifier is modifiable.

[0012] According to still another embodiment of the present invention, the assigned mobile station identifier is stored in a memory associated with the controller.

[0013] According to yet another embodiment of the present invention, the assigned mobile station identifier is modifiable by an external control device coupled to the proxy mobile station.

[0014] According to a further embodiment of the present invention, the controller transmits the reverse channel data using the assigned mobile station identifier associated with the mobile station in response to a command received from the external control device.

[0015] According to a still further embodiment of the present invention, the controller is further capable of receiving reverse channel data to be transmitted to the base station and transmitting the reverse channel data using a default mobile station identifier associated with the proxy mobile station.

[0016] According to a yet further embodiment of the present invention, the default mobile station identifier is stored in a memory associated with the controller.

[0017] Before undertaking the DETAILED DESCRIPTION OF THE INVENTION below, it may be advantageous to set forth definitions of certain words and phrases used throughout this patent document: the terms “include” and “comprise,” as well as derivatives thereof, mean inclusion without limitation; the term “or,” is inclusive, meaning and/or; the phrases “associated with” and “associated therewith,” as well as derivatives thereof, may mean to include, be included within, interconnect with, contain, be contained within, connect to or with, couple to or with, be communicable with, cooperate with, interleave, juxtapose, be proximate to, be bound to or with, have, have a property of, or the like; and the term “controller” means any device, system or part thereof that controls at least one operation, such a device may be implemented in hardware, firmware or software, or some combination of at least two of the same. It should be noted that the functionality associated with any particular controller may be centralized or distributed, whether locally or remotely. Definitions for certain words and phrases are provided throughout this patent document, those of ordinary skill in the art should understand that in many, if not most instances, such definitions apply to prior, as well as future uses of such defined words and phrases.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] For a more complete understanding of the present invention and its advantages, reference is now made to the following description taken in conjunction with the accompanying drawings, in which like reference numerals represent like parts:

[0019] FIG. 1 illustrates an exemplary wireless network that implements a plurality of proxy translators according to the principles of the present invention;

[0020] FIG. 2 illustrates the exemplary proxy translators in FIG. 1 in greater detail according to an exemplary embodiment of the present invention;

[0021] FIG. 3 is a message flow diagram illustrating the operation of a proxy translator during a mobile-terminated call operation according to one embodiment of the present invention;

[0022] FIG. 4 is a message flow diagram illustrating the operation of a proxy translator during a mobile-originated call operation according to another embodiment of the present invention;

[0023] FIG. 5 is a message flow diagram 500 illustrating a handoff between two proxy translators according to the principles of the present invention; and

[0024] FIG. 6 illustrates a proxy mobile station that implements an assignable mobile station identifier according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0025] FIGS. 1 through 6, discussed below, and the various embodiments used to describe the principles of the present invention in this patent document are by way of illustration only and should not be construed in any way to limit the scope of the invention. Those skilled in the art will understand that the principles of the present invention may be implemented in any suitably arranged wireless network.

[0026] FIG. 1 illustrates exemplary wireless network 100, implements a plurality of proxy translators according to the principles of the present invention. Wireless network 100 comprises a plurality of cell sites 121-123, each containing one of the base stations, BS 101, BS 102, or BS 103. Base stations 101-103 communicate with a plurality of mobile stations (MS) 111-114 using, for example, the CDMA2000 air interface standard. In an advantageous embodiment of the present invention, mobile stations 111-114 are capable of receiving data traffic and/or voice traffic on two or more channels simultaneously. Mobile stations 111-114 may be any suitable wireless devices (e.g., conventional cell phones, PCS handsets, personal digital assistant (PDA) handsets, portable computers, telemetry devices) that are capable of communicating with base stations 101-103 via wireless links.

[0027] The present invention is not limited to communicating with mobile devices. The present invention also encompasses other types of wireless access terminals, including fixed wireless terminals. For the sake of simplicity, only mobile stations are shown and discussed hereafter. However, it should be understood that the use of the term “mobile station” in the claims and in the description below is intended to encompass both truly mobile devices (e.g., cell phones, wireless laptops) and stationary wireless terminals (e.g., a machine monitor with wireless capability).

[0028] Dotted lines show the approximate boundaries of cell sites 121-123 in which base stations 101-103 are located. The cell sites are shown approximately circular for the purposes of illustration and explanation only. It should be clearly understood that the cell sites may have other irregular shapes, depending on the cell configuration selected and natural and man-made obstructions.

[0029] As is well known in the art, each of cell sites 121-123 is comprised of a plurality of sectors, where a directional antenna coupled to the base station illuminates each sector. The embodiment of FIG. 1 illustrates the base station in the center of the cell. Alternate embodiments may position the directional antennas in corners of the sectors. The system of the present invention is not limited to any particular cell site configuration.

[0030] In one embodiment of the present invention, each of BS 101, BS 102 and BS 103 comprises a base station controller (BSC) and one or more base transceiver subsystem(s) (BTS). Base station controllers and base transceiver subsystems are well known to those skilled in the art. A base station controller is a device that manages wireless communications resources, including the base transceiver

subsystems, for specified cells within a wireless communications network. A base transceiver subsystem comprises the RF transceivers, antennas, and other electrical equipment located in each cell site. This equipment may include air conditioning units, heating units, electrical supplies, telephone line interfaces and RF transmitters and RF receivers. For the purpose of simplicity and clarity in explaining the operation of the present invention, the base transceiver subsystems in each of cells **121**, **122** and **123** and the base station controller associated with each base transceiver subsystem are collectively represented by BS **101**, BS **102** and BS **103**, respectively.

[0031] BS **101**, BS **102** and BS **103** transfer voice and data signals between each other and the public switched telephone network (PSTN) (not shown) via communication line **131** and mobile switching center (MSC) **140**. BS **101**, BS **102** and BS **103** also transfer data signals, such as packet data, with the Internet (not shown) via communication line **131** and packet data server node (PDSN) **150**. Packet control function (PCF) unit **190** controls the flow of data packets between base stations **101-103** and PDSN **150**. PCF unit **190** may be implemented as part of PDSN **150**, as part of MSC **140**, or as a stand-alone device that communicates with PDSN **150**, as shown in FIG. 1. Line **131** also provides the connection path for control signals transmitted between MSC **140** and BS **101**, BS **102** and BS **103** that establish connections for voice and data circuits between MSC **140** and BS **101**, BS **102** and BS **103**.

[0032] Communication line **131** may be any suitable connection means, including a T1 line, a T3 line, a fiber optic link, a network packet data backbone connection, or any other type of data connection. Line **131** links each vocoder in the BSC with switch elements in MSC **140**. The connections on line **131** may transmit analog voice signals or digital voice signals in pulse code modulated (PCM) format, Internet Protocol (IP) format, asynchronous transfer mode (ATM) format, or the like.

[0033] MSC **140** is a switching device that provides services and coordination between the subscribers in a wireless network and external networks, such as the PSTN or Internet. MSC **140** is well known to those skilled in the art. In some embodiments of the present invention, communications line **131** may be several different data links where each data link couples one of BS **101**, BS **102**, or BS **103** to MSC **140**.

[0034] In the exemplary wireless network **100**, MS **111** is located in cell site **121** and is in communication with BS **101**. MS **113** is located in cell site **122** and is in communication with BS **102**. MS **114** is located in cell site **123** and is in communication with BS **103**. MS **112** is also located close to the edge of cell site **123** and is moving in the direction of cell site **123**, as indicated by the direction arrow proximate MS **112**. At some point, as MS **112** moves into cell site **123** and out of cell site **121**, a hand-off will occur.

[0035] Natural and man-made obstacles create radio frequency (RF) holes in the coverage area of wireless network **100**. By way of example, RF hole **165** (indicated by dotted line) exists in cell site **121**. If MS **111** or MS **112** enters RF hole **165**, an existing voice call or data call connection may be dropped. Also, MS **111** or MS **112** may not be able to reliably establish new call connections.

[0036] Accordingly, to eliminate RF holes, such as RF hole **165**, and to extend coverage area, wireless network **100**

further comprises proxy translator (PT) **161** and proxy translator (PT) **162**. PT **161** is disposed near the outer boundary of cell site **121** and extends the range of BS **101** to reach mobile stations that are in the vicinity of PT **161**, but just outside the coverage area of cell site **121**. Deploying PT **161** in this manner may be necessary if it would be prohibitively expensive to add a new cell site next to cell site **121**. PT **162** is disposed near the edge of RF hole **165** and improves coverage within RF hole **165**. Advantageously, PT **161** increases the strength of forward and reverse channel signals only in the vicinity of the outer edge of cell site **121** and PT **162** increases the strength of forward and reverse channel signals only in the vicinity of RF hole **165**. Thus, the amount of increased signal interference in adjacent cell sites **122** and **123** is minimal or non-existent.

[0037] FIG. 2 illustrates exemplary proxy translators **161** and **162** in greater detail according to an exemplary embodiment of the present invention. Since proxy translator (PT) **161** and proxy translator (PT) **162** are substantially identical, it is unnecessary and redundant to explain the operation of each PT separately. Therefore, the explanation of the present invention that follows will generally be limited to discussion of PT **162**.

[0038] PT **162** comprises proxy mobile station pool **210**, proxy base transceiver subsystem (BTS) **220**, and proxy translator controller **230**, and antenna **241-243**. Proxy translator controller **230** directs the overall operation of PT **162**. Proxy mobile station pool **210** comprises N proxy mobile stations, including exemplary proxy mobile stations **211-214**. Proxy mobile station (MS) **211**, proxy mobile station (MS) **212**, proxy mobile station (MS) **213**, and proxy mobile station (MS) **214** are arbitrarily labeled Proxy MS 1, Proxy MS 2, Proxy MS 3, and Proxy MS n, respectively.

[0039] Proxy mobile stations **211-214** communicate with base station **101** via antenna **241**. Proxy BTS **220** communicates with mobile stations **251** and **252** via main antenna **242** and, optionally, via a receive diversity antenna **243**. Mobile station (MS) **251** and mobile station (MS) **252** are disposed in or near RF hole **165** (or, in the case of PT **161**, near or beyond the outer boundary of cell site **121**). According to an advantageous embodiment of the present invention, each one of the proxy mobile stations in proxy mobile station pool **210** comprises a programmable (or configurable) RF transceiver and associated signal processing circuits that are capable of performing all of the functions of a conventional wireless mobile station, such as, for example, a CDMA2000 compatible cell phone or similar wireless terminal.

[0040] Proxy mobile stations **211-214** in proxy translator **162** are located at the edge of the region of good coverage and operate in conjunction with BS **101** to provide extended coverage in RF hole **165**. Each one of proxy mobile stations **211-214** is capable of serving as a proxy or substitute for MS **251** or MS **252** or other mobile stations in RF hole **165**. Each one of proxy mobile stations **211-214** communicates with BS **101** on the CDMA air interface on behalf of one of MS **251** or MS **252** or other mobile stations in RF hole **165**. Proxy BTS **220**, also placed at the edge of the region of good coverage, communicates with MS **251** or MS **252** or other mobile stations in RF hole **165** as a proxy or substitute for BS **101**. A selected one of proxy mobile stations **211-214** receives overhead channels from BS **101** and transfers the

overhead channel signals to proxy BTS 220, which transmits the overhead signals to MS 251, MS 252, and other mobile stations in RF hole 165.

[0041] Proxy translator controller 230 assigns a proxy mobile station (e.g., proxy MS 211) as a substitute for each mobile station (e.g., MS 251) in RF hole 165. During a call, the assigned proxy mobile station 211 communicates with BS 101 while proxy BTS 220 communicates with mobile station 251. A data link between proxy BTS 220 and proxy MS 211 transfers the user data and control signals on the forward and reverse links. This mimics the operation of MS 251 if MS 251 were capable of direct communication with BS 101. This enables wireless network 100 to treat MS 251 as a normal mobile station. Proxy translator controller 230 dynamically assigns and de-assigns the mobile station identifier (MS_ID) of MS 251 to proxy MS 211 as MS 251 enters and exits RF hole 165. Thus, from the perspective of BS 101, proxy MS 211 appears to be the same device as MS 251.

[0042] The mobile station identifier (MS_ID) of MS 251 (or any other mobile station) is a fixed length (e.g., 32 bits, 64 bits) value or variable length value that uniquely describes the mobile station (or other wireless terminal). The MS_ID may comprise a conventional identifier, such as an Electronic Serial Number (ESN), a User Identity Module (UIM) ID, a Subscriber Identity Module (SIM) ID, or a Mobile Equipment Identifier (MEID), among others.

[0043] In the forward channel, proxy BTS 220 multiplexes and transmits only the user data information received from active (or assigned) proxy mobile stations in proxy mobile station pool 210. Thus, only forward channel signals directed to MS 251, MS 252 or other mobile stations in RF hole 165 are retransmitted. This results in much less transmit power in the forward channel compared to conventional repeaters, which retransmit all forward channels signals, including forward channels signals for mobile stations that are not in or near RF hole 165. In the reverse channel, proxy BTS 220 receives reverse channel signals from MS 252, MS 251 and other mobile station in or near RF hole 165. The reverse channel signals are demodulated and transferred to the appropriate one of proxy mobile stations 211-214 for retransmission to BS 101.

[0044] According to an exemplary embodiment of the present invention, control messages and user data traffic in the forward and reverse channels are transferred between proxy BTS 220 and proxy mobile stations 211-214 as proxy signals. For the purposes of this disclosure, the term "proxy signals" may include baseband signals, intermediate frequency (IF) signals, radio frequency (RF) signals, or any other form of processed signals that may be derived from the actual signals received by antennas 241-243. For example, proxy BTS 220 may down-convert a reverse channel RF signal received from antenna 242 to a baseband signal, an IF signal, or another RF signal that is transferred to proxy mobile station 211. Proxy MS 211 then up-converts the proxy signal from proxy BTS 220 for retransmission to BS 101. Similarly, proxy MS 211 may convert a forward channel RF signal received from antenna 241 to a baseband signal, an IF signal, or another RF signal that is transferred to proxy BTS 220. Proxy BTS 220 then up-converts the proxy signal from proxy MS 211 for retransmission to mobile stations 251 and 252.

[0045] Proxy translator 162 transmits on the same frequency and pseudo-random noise (PN) offset as BS 101.

Proxy translator 162 is designed to utilize high front-to-back isolation of the antenna system such that forward channel signals re-transmitted to MS 251 and MS 252 do not interfere with the forward channel signals received from BS 101. Because proxy translator 162 transmits on the same PN offset as BS 101, a handoff operation to another base station remains the same as that of BS 101 under normal configuration.

[0046] If MS 251 is initially off and is activated when it is already in RF hole 165, MS 251 initially detects the control signals (pilot, access, etc.) that are transmitted by proxy translator 162. Since these control signals are the same as the control signals transmitted by BS 101, MS 251 accesses proxy translator 162 in the same manner that MS 251 would access BS 101. Thus, MS 251 transmits the mobile station identifier (e.g., ESN) associated with MS 251 as part of the normal process of accessing a base station under, for example, the CDMA2000 protocol). When proxy translator 162 receives the mobile station identifier from MS 251, proxy translator 162 programs proxy mobile station 211 to use the same mobile station identifier to access BS 101. Thus, proxy mobile station 211 appears the same to BS 101 as MS 251 would appear.

[0047] However, MS 251 may not always be activated after MS 251 is already in RF hole 165. In many situations, MS 251 may roam into RF hole 165 after MS 251 has already accessed BS 101. In this situation proxy translator 162 must obtain the mobile station identifier from MS 251 by some other means. In one embodiment of the present invention, when proxy translator 162 detects the present of MS 251, proxy translator 162 may use a new special-purpose control channel message that prompts MS 251 to re-transmit its mobile station identifier. As an example of implementation for the CDMA2000 family of standards, changes may be made to existing CDMA2000 protocol messages, including base station-assigned messages such as the Extended Channel Assignment Message (ECAM), the Universal Handoff Direction Message (UHDM), and the In-Traffic System Parameters Message (ITSPM). The changes may be made to fields carrying the identifier information, either as a part of upper layer signaling or as a part of LAC addressing. To prevent the mobile station identifier information from being misused by hackers, the mobile station identifier may be encrypted before it is sent over the air.

[0048] In an alternate embodiment of the present invention, proxy translator may use a special-purpose traffic channel message that prompts MS 251 to re-transmit its mobile station identifier. By way of example, U.S. patent application Ser. No. 10/672,607, filed Sep. 26, 2003, entitled "System and Method for Providing Mobile Station Registration in a Traffic Channel in a Wireless Communication System" discloses a wireless network that uses a traffic channel to register a mobile station and to obtain an ESN from the mobile station. U.S. patent application Ser. No. 10/672,607, which is assigned to the assignee of the present application, is hereby incorporated by reference into the present disclosure as if fully set forth herein.

[0049] FIG. 3 depicts message flow diagram 300, which illustrates the operation of proxy translator 162 during a mobile-terminated call operation according to an exemplary embodiment of the present invention. In FIG. 3, it is

assumed that MS 251 has roamed into, or was activated within, the coverage area of proxy translator 162 and has already accessed wireless network 100 via PT 162. Initially, BS 101 transmits Page message 301 in the forward channel to proxy mobile station 211 via the air interface. Proxy mobile station 211 then transmits Page message 302 as a proxy signal via wireline 350 to proxy BTS 220. Finally, proxy BTS 220 transmits Page message 303 via the air interface to mobile station 251.

[0050] Mobile station 251 responds in the reverse channel by transmitting Page Response message 304 via the air interface to proxy BTS 220. Proxy BTS then transmits Page Response message 305 as a proxy signal via wireline 350 to proxy mobile station 211. Finally, proxy mobile station 211 transmits Page Response message 306 via the air interface to base station 101. Next, BS 101 transmits Channel Assignment message 307 in the forward channel to proxy mobile station 211 via the air interface. Proxy mobile station 211 then transmits Channel Assignment message 308 as a proxy signal via wireline 350 to proxy BTS 220. Proxy BTS 220 then transmits Channel Assignment message 309 via the air interface to mobile station 251.

[0051] BS 101 transmits Null Frames 310 in the forward channel to proxy mobile station 211 via the air interface. Proxy mobile station 211 then transmits Null Frames 311 as a proxy signal via wireline 350 to proxy BTS 220. Proxy BTS 220 then transmits Null Frames 312 via the air interface to mobile station 251. Mobile station 251 responds in the reverse channel by transmitting Preambles 313 via the air interface to proxy BTS 220. Proxy BTS then transmits Preambles 314 as a proxy signal via wireline 350 to proxy mobile station 211. Finally, proxy mobile station 211 transmits Preambles 315 via the air interface to base station 101.

[0052] The message flow in FIG. 3 continues for the duration of the call session, as conventional CDMA2000 messages are transmitted between MS 101 and MS 251 using PT 162 as an intermediary. It is not necessary to illustrate the remainder of the call session, however.

[0053] FIG. 4 depicts message flow diagram 400, which illustrates the operation of proxy translator 162 during a mobile-originated call operation according to an exemplary embodiment of the present invention. In FIG. 4, it is assumed that MS 251 has roamed into, or was activated within, the coverage area of proxy translator 162 and has already accessed wireless network 100 via PT 162. Initially, mobile station 251 transmits in the reverse channel by transmitting Origination message 401 via the air interface to proxy BTS 220. Proxy BTS then transmits Origination message 402 as a proxy signal via wireline 350 to proxy mobile station 211. Finally, proxy mobile station 211 transmits Origination message 403 via the air interface to base station 101.

[0054] Next, BS 101 transmits Channel Assignment message 404 in the forward channel to proxy mobile station 211 via the air interface. Proxy mobile station 211 then transmits Channel Assignment message 405 as a proxy signal via wireline 350 to proxy BTS 220. Proxy BTS 220 then transmits Channel Assignment message 406 via the air interface to mobile station 251.

[0055] BS 101 transmits Null Frames 407 in the forward channel to proxy mobile station 211 via the air interface.

Proxy mobile station 211 then transmits Null Frames 408 as a proxy signal via wireline 350 to proxy BTS 220. Proxy BTS 220 then transmits Null Frames 409 via the air interface to mobile station 251. Mobile station 251 responds in the reverse channel by transmitting Preambles 410 via the air interface to proxy BTS 220. Proxy BTS then transmits Preambles 411 as a proxy signal via wireline 350 to proxy mobile station 211. Finally, proxy mobile station 211 transmits Preambles 412 via the air interface to base station 101.

[0056] The message flow in FIG. 4 continues for the duration of the call session, as conventional CDMA2000 messages are transmitted between MS 101 and MS 251 using PT 162 as an intermediary. It is not necessary to illustrate the remainder of the call session, however.

[0057] Advantageously, the present invention does not retransmit all of the received RF signals from BS 101. Instead, proxy BTS 220 and proxy MS 211 only retransmit signals for mobile stations within or near RF hole 165. With a lower noise floor in the poor coverage area, the performance of the entire cell coverage by BS 101 is improved. Also, proxy translator 162 is able to communicate over the air with an existing base station and does not need any other network connections in order to function.

[0058] Since proxy mobile stations 211-214 imitate (or "spoof") the control and traffic signals of actual mobile stations and proxy BTS 220 imitates the control and traffic signals of BS 101, it is possible to daisy chain two or more proxy translators. For example, if proxy translator 161 is close enough to proxy translator 162, proxy mobile stations 211-214 of proxy translator 161 may communicate with proxy BTS 220 of proxy translator 162. Thus, at one end, proxy mobile stations 211-214 of proxy translator 162 would communicate with BS 101. At the other end, proxy BTS 220 of proxy translator 161 would communicate with mobile stations 251 and 252. In the middle, proxy mobile stations 211-214 of proxy translator 161 would communicate with proxy BTS 220 of proxy translator 162.

[0059] Even if two proxy translators are not set up in a daisy chain configuration, it still is possible for two proxy translators to interoperate. For example, it is possible to perform a handoff of a mobile station from a first proxy translator to a second proxy translator. Such a handoff is described below with respect to FIG. 5.

[0060] FIG. 5 depicts message flow diagram 500, which illustrates a handoff operation between two proxy translators according to the principles of the present invention. For example, if proxy translator 161 is close enough to proxy translator 162, mobile station 251 could be handed off from proxy translator 162 to proxy translator 162, or vice versa. In FIG. 5, it is assumed that MS 251 has roamed into, or was activated within, the coverage area of proxy translator 162 and has already accessed wireless network 100 via PT 162.

[0061] In the operation depicted in FIG. 5, MS 251 is handed off from a first base transceiver subsystem (BTS1) associated with BS 101 to a second base transceiver subsystem (BTS2) associated with BS 101. PT 162 communicates with BTS1 and transmits the forward and reverse traffic channel signals and the control channel signals (including the pilot signal) associated with PT 162. Similarly, PT 161 communicates with BTS2 and transmits the forward and reverse traffic channel signals and the control channel signals (including the pilot signal) associated with PT 161.

[0062] During routine operation, mobile station 251 transmits Pilot Strength Measurement message (PSMM) 501a to proxy BTS 220a in PT 162. PSMM 501a reports the strengths of the pilot signals from PT 162 and PT 161, as seen by MS 251. Proxy BTS 220a transmits PSMM 501b to proxy mobile station 211a, which transmits PSMM 501c to BTS1. Since the pilot signal from PT 161 is stronger than the pilot signal from PT 162, BTS1 transmits Handoff (HO) Request message 502 to the base station controller (BSC) of BS 101.

[0063] In response to Handoff Request message 502, the BSC transmits Assignment Request and Confirmation (ARC) message 503a to BTS1. BTS 1 then transmits ARC message 503b to proxy mobile station 211a, which transmits ARC message 503c to proxy BTS 220a. The BSC also transmits Handoff Direction message (HDM) 504a to BTS1. BTS1 then transmits HDM 504b to proxy mobile station 211a, which transmits HDM 504c to proxy BTS 220a. Proxy BTS 220a then transmits HDM 504d to MS 251.

[0064] In response, MS 251 transmits Handoff Completion message (HCM) 505a to proxy BTS 220b of PT 161. Proxy BTS 220b transmits HCM 505b to proxy mobile station 211b, which transmits HCM 505c to BTS2 in BS 101. Finally, BTS2 transmits HCM 505d to the BSC, thereby completing the handoff of MS 251 from PT 162 to PT 161.

[0065] Those skilled in the art will understand that the handoff procedure described in FIG. 5 is not limited to handoffs between base transceiver subsystems associated with the same base station. Those skilled in the art will be able to adapt the message flow in FIG. 5 to provide an alternate embodiment which performs a handoff from a first BTS associated with a first base station to a second BTS associated with a second base station via the mobile switching center (MSC) of a wireless network. Such an alternate embodiment will still fall within the scope of the present invention.

[0066] FIG. 6 illustrates an exemplary embodiment of proxy mobile station 211, which implements an assignable mobile station identifier according to the principles of the present invention. Proxy mobile station 211 comprises antenna 605, radio frequency (RF) transceiver (X-CVR) 610, encoding-decoding circuit block 615, proxy mobile station (MS) controller 620, and memory 630. Memory 630 stored default mobile station identifier (MS_ID) 631 and assigned mobile station identifier (MS_ID) 632. In essence, proxy mobile station 211 comprises all of the functional components of a conventional mobile station, such as a cell phone (e.g., CDMA, GSM) or a wireless network terminal (e.g., 802.11g card).

[0067] In the forward channel, RF transceiver 610 receives incoming RF signals from BS 101 via antenna 605 and down-converts the received RF signals to, for example, a baseband signal or an IF signal. The output of RF transceiver 610 is channel decoded by encoding-decoding circuit block 615. The decoded output of encoding-decoding circuit block 615 comprises user data from a traffic channel or a control channel signal (i.e., pilot, paging) from one of the control channels of BS 101. Proxy MS controller 620 transfers the user data or control channel signal to proxy BTS 220.

[0068] In the reverse channel, proxy MS controller 620 receives mobile station data traffic or mobile station control

channel signals from proxy BTS controller 220. Proxy mobile station controller 620 encodes the reverse channel data using either default mobile station identifier 631 or assigned mobile station identifier 632. Encoding-decoding circuit block 615 channel encodes the encoded output of proxy MS controller 620. RF transceiver 610 then up-converts the channel-encoded output of encoding-decoding circuit block 615 for transmission via antenna 605.

[0069] Proxy mobile station 211 may communicate in the reverse channel on its own behalf using default mobile station identifier 631. This may be done, for example, to enable communication between BS 101 and proxy translator controller 230 in order to download software or data proxy translator 162. However, proxy mobile station 211 communicates in the reverse channel using assigned mobile station identifier 632 whenever proxy mobile station 211 is acting as a proxy for a mobile station, such as MS 251, that is communicating with proxy BTS 220.

[0070] Proxy translator controller 230 receives the mobile station identifier of MS 251 using one of the methods described above and transmits the receiver mobile station identifier to proxy MS controller 620 for storage in assigned mobile station identifier 632 in memory 630. Proxy translator controller 230 then sends a command to proxy MS controller 620 that causes proxy MS controller 620 to use the value in assigned mobile station identifier 632 to encode user data traffic in the reverse channel. Once the assignment of mobile identifier to proxy mobile station 211 is successful, proxy mobile station 211 is capable of mimicking the actual mobile device 251.

[0071] Although the present invention has been described with an exemplary embodiment, various changes and modifications may be suggested to one skilled in the art. It is intended that the present invention encompass such changes and modifications as fall within the scope of the appended claims.

What is claimed is:

1. For use in a wireless network, a proxy mobile station capable of retransmitting reverse channel signals from a mobile station to a base station of said wireless network, said proxy mobile station comprising:

a controller capable of receiving reverse channel data to be transmitted to said base station and transmitting said reverse channel data using an assigned mobile station identifier associated with said mobile station; and

a radio frequency transceiver capable of up-converting said encoded reverse channel data for transmission to said base station.

2. The proxy mobile station as set forth in claim 1, wherein said controller encodes said reverse channel data using said assigned mobile station identifier.

3. The proxy mobile station as set forth in claim 2, wherein said assigned mobile station identifier is modifiable.

4. The proxy mobile station as set forth in claim 3, wherein said assigned mobile station identifier is stored in a memory associated with said controller.

5. The proxy mobile station as set forth in claim 3, wherein said assigned mobile station identifier is modifiable by an external control device coupled to said proxy mobile station.

6. The proxy mobile station as set forth in claim 5, wherein said controller transmits said reverse channel data using said assigned mobile station identifier associated with said mobile station in response to a command received from said external control device.

7. The proxy mobile station as set forth in claim 6, wherein said controller is further capable of receiving reverse channel data to be transmitted to said base station and transmitting said reverse channel data using a default mobile station identifier associated with said proxy mobile station.

8. The proxy mobile station as set forth in claim 7, wherein said default mobile station identifier is stored in a memory associated with said controller.

9. A repeater capable of retransmitting reverse channel signals from a plurality of mobile stations to a base station of a wireless network, said repeater comprising:

a plurality of proxy mobile stations capable of retransmitting said reverse channel signals, wherein each of said proxy mobile stations comprises:

a controller capable of receiving reverse channel data to be transmitted to said base station and transmitting said reverse channel data using an assigned mobile station identifier associated with a first one of said plurality of mobile stations; and

a radio frequency transceiver capable of up-converting said encoded reverse channel data for transmission to said base station.

10. The repeater as set forth in claim 9, wherein said controller encodes said reverse channel data using said assigned mobile station identifier.

11. The repeater as set forth in claim 10, wherein said assigned mobile station identifier is modifiable.

12. The repeater as set forth in claim 11, wherein said assigned mobile station identifier is stored in a memory associated with said controller.

13. The repeater as set forth in claim 11, wherein said assigned mobile station identifier is modifiable by an external control device coupled to said each proxy mobile station.

14. The repeater as set forth in claim 13, wherein said controller transmits said reverse channel data using said assigned mobile station identifier associated with said first mobile station in response to a command received from said external control device.

15. The repeater as set forth in claim 14, wherein said controller is further capable of receiving reverse channel data to be transmitted to said base station and transmitting said reverse channel data using a default mobile station identifier associated with said each proxy mobile station.

16. The repeater as set forth in claim 15, wherein said default mobile station identifier is stored in a memory associated with said controller.

17. For use in a wireless network, a method of retransmitting reverse channel signals from a mobile station to a base station of said wireless network, the method comprising the steps of:

receiving in a proxy mobile station reverse channel data to be transmitted to the base station;

transmitting the reverse channel data from the proxy mobile station to the base station using an assigned mobile station identifier associated with the mobile station.

18. The method as set forth in claim 17, further comprising the step of encoding the reverse channel data using the assigned mobile station identifier.

19. The method as set forth in claim 18, wherein the assigned mobile station identifier is modifiable.

20. The method as set forth in claim 19, wherein the assigned mobile station identifier is modifiable by an external control device coupled to the proxy mobile station.

21. The method as set forth in claim 20, wherein the step of transmitting the reverse channel data using the assigned mobile station identifier associated with the mobile station is performed in response to a command received from the external control device.

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