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(54) **METHOD OF A SERVING BASE STATION FOR FACILITATING A MOBILE STATION TO PERFORM A FAST HANDOFF**

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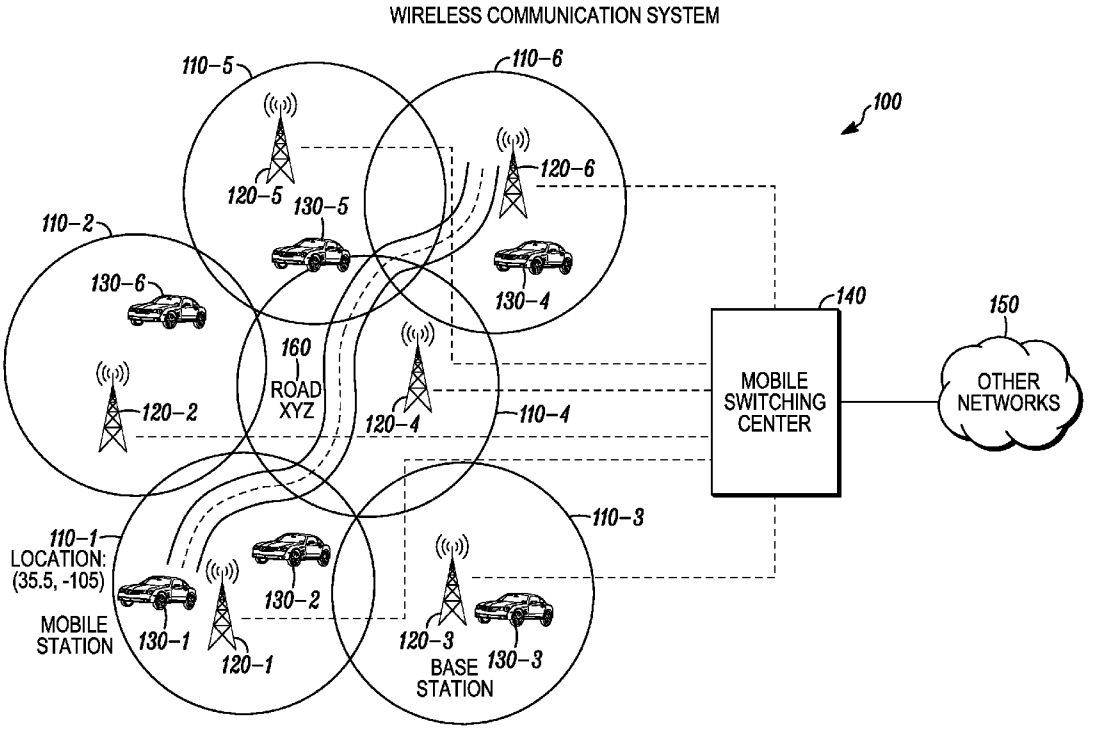
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(57) **ABSTRACT**

A method for facilitating a mobile station to perform a fast handoff in a wireless communication system allows a handoff procedure to be anticipated (by the mobile station, its serving base station, or both) based on historical information regarding prior successful handoff procedures. In operation, the serving base station monitors (**510**) current mobile station parameters and compares them with historical data. If the parameters indicate a high probability target base station (**515**), the serving base station requests allocation (**525**) of air interface resources at the high probability target base station prior to the mobile station reporting reception of signal from the high probability target base station. This facilitates fast handoff from the serving base station to the high probability target base station.



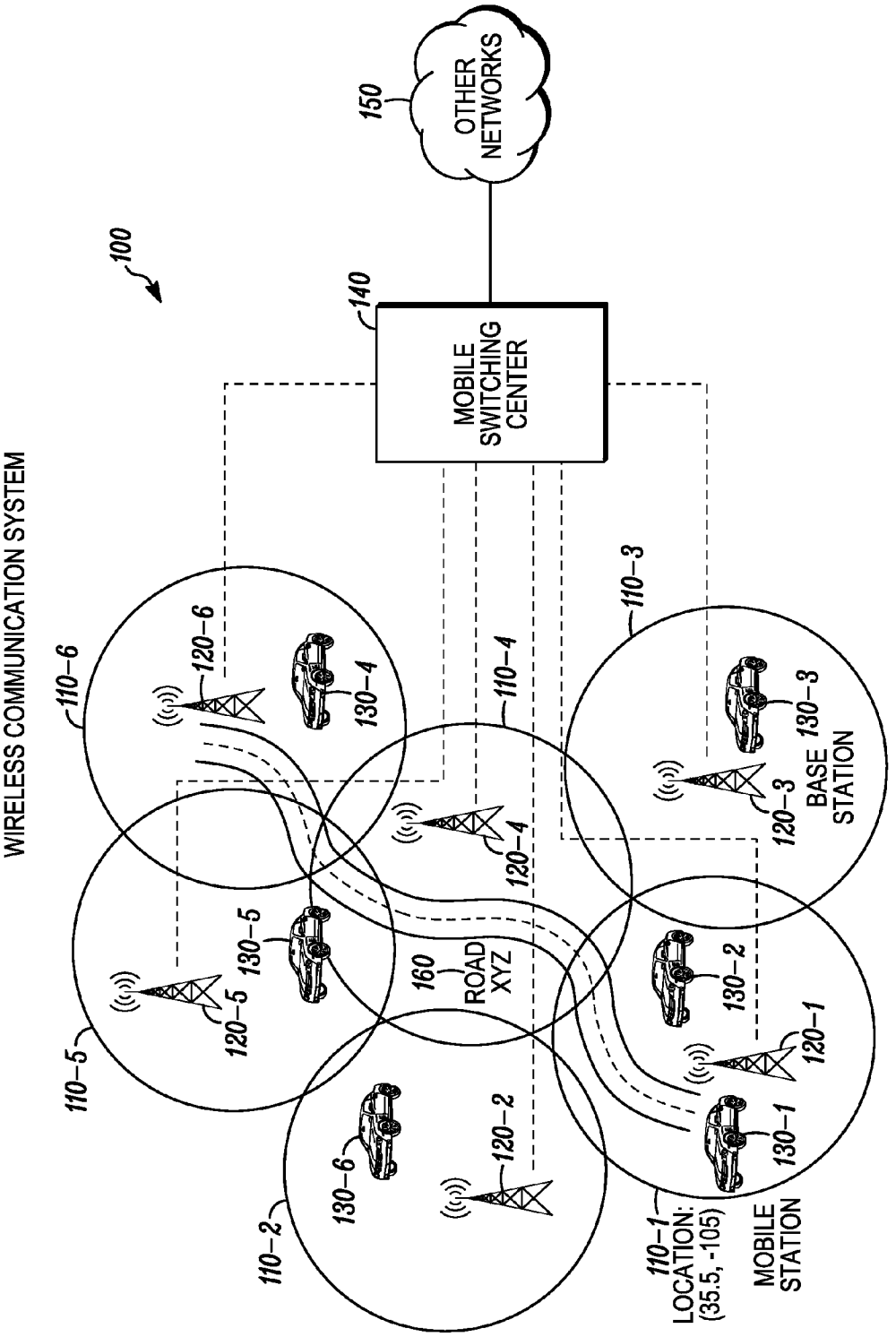

WIRELESS COMMUNICATION SYSTEM
100
150
OTHER NETWORKS
140
MOBILE SWITCHING CENTER
110-6
120-6
130-4
110-4
120-4
110-3
130-3
120-3
BASE STATION
110-5
120-5
130-5
160
ROAD XYZ
130-2
120-1
110-2
130-6
120-2
130-1
110-1
LOCATION: (35.5, -105)
MOBILE STATION

FIG. 1

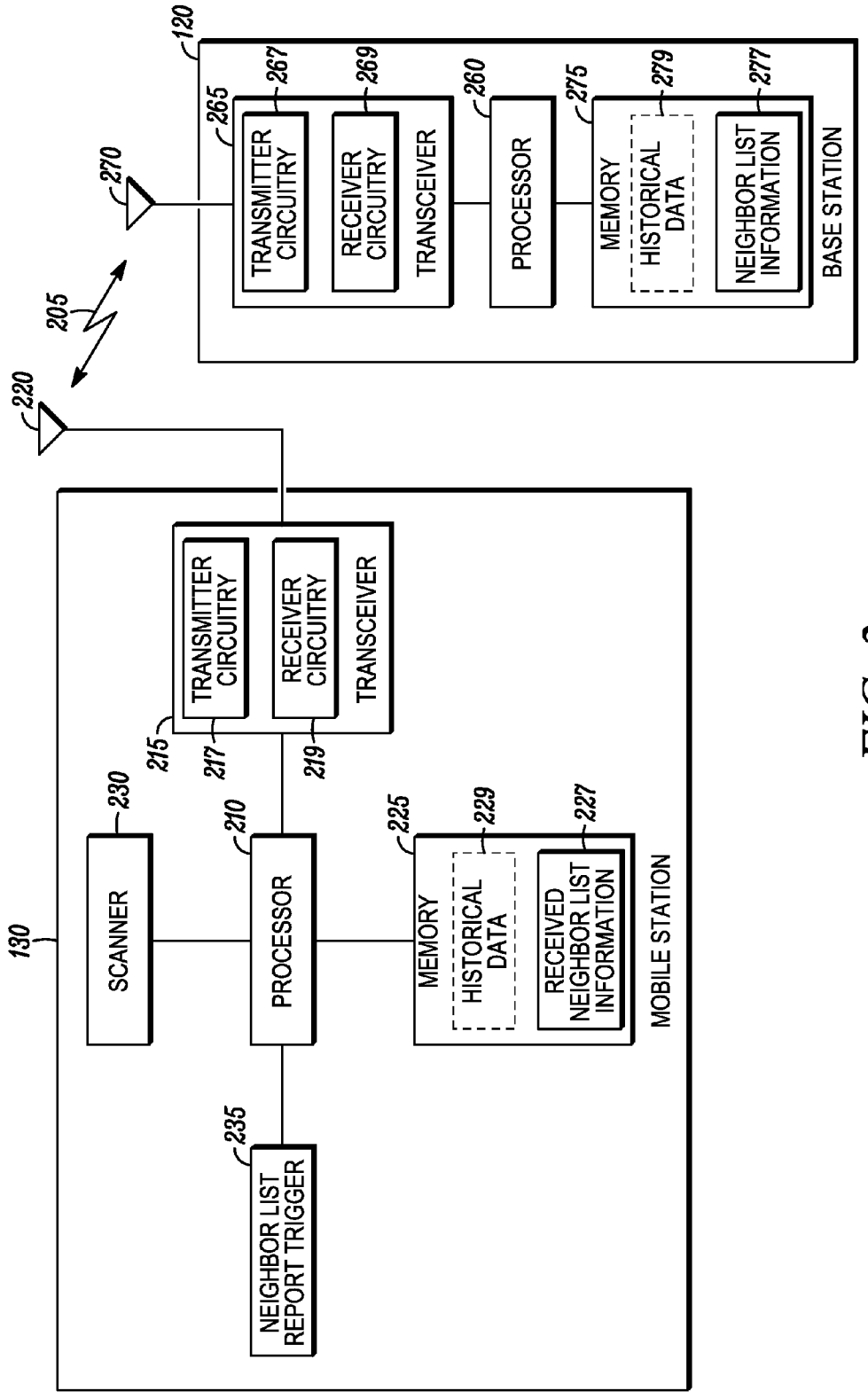

120
265
267
269
260
275
279
277
TRANSMITTER CIRCUITRY
RECEIVER CIRCUITRY
TRANSCEIVER
PROCESSOR
MEMORY
HISTORICAL DATA
NEIGHBOR LIST INFORMATION
BASE STATION
270
205
220
215
217
219
TRANSMITTER CIRCUITRY
RECEIVER CIRCUITRY
TRANSCEIVER
230
210
225
229
227
130
SCANNER
PROCESSOR
MEMORY
HISTORICAL DATA
RECEIVED NEIGHBOR LIST INFORMATION
MOBILE STATION
235
NEIGHBOR LIST REPORT TRIGGER

FIG. 2

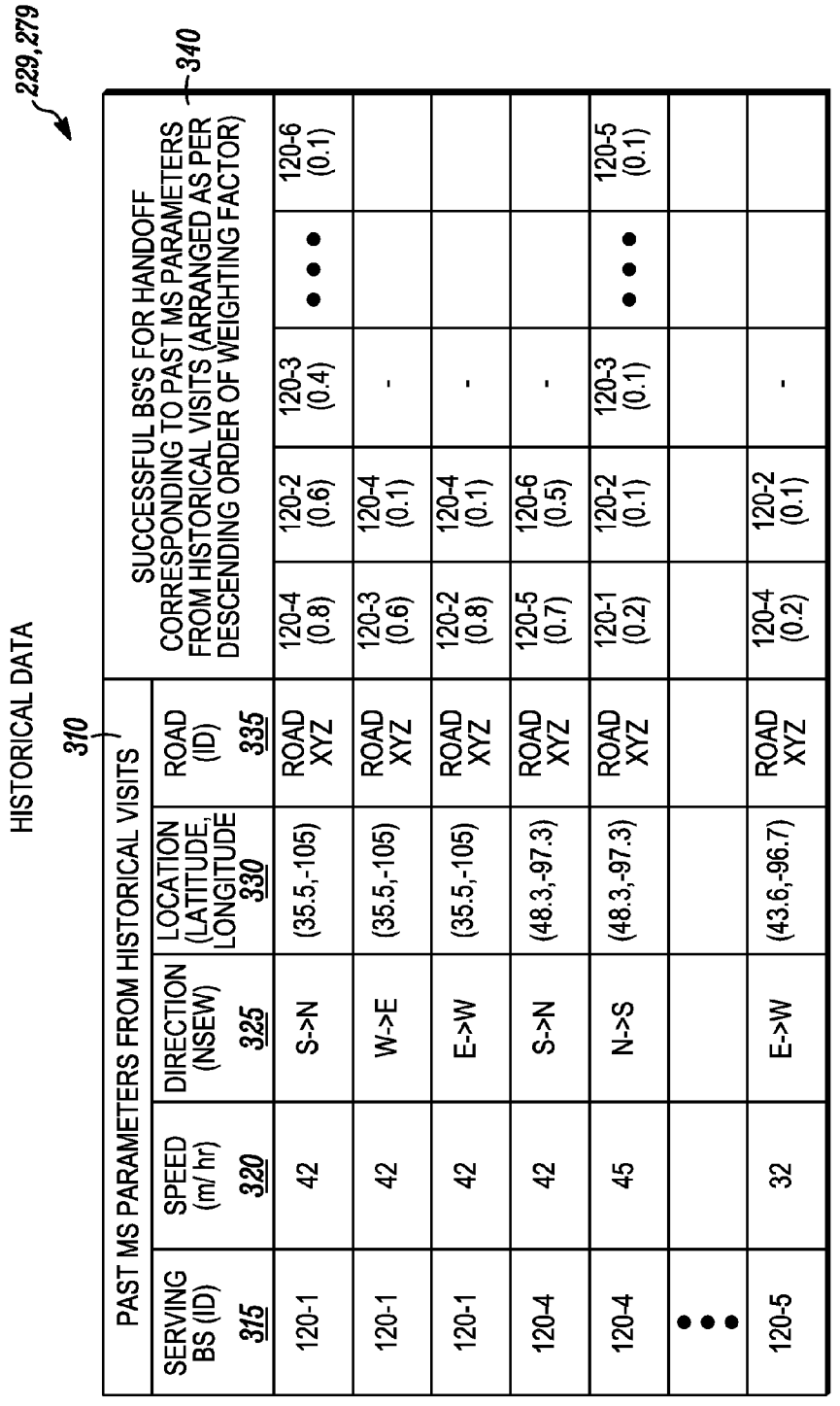

229,279
HISTORICAL DATA
310
340
PAST MS PARAMETERS FROM HISTORICAL VISITS
SUCCESSFUL BS'S FOR HANDOFF CORRESPONDING TO PAST MS PARAMETERS FROM HISTORICAL VISITS (ARRANGED AS PER DESCENDING ORDER OF WEIGHTING FACTOR)
SERVING BS (ID) 315
SPEED (m/ hr) 320
DIRECTION (NSEW) 325
LOCATION (LATITUDE, LONGITUDE 330
ROAD (ID) 335
120-1 42 S->N (35.5,-105) ROAD XYZ 120-4 (0.8) 120-2 (0.6) 120-3 (0.4) • • • 120-6 (0.1)
120-1 42 W->E (35.5,-105) ROAD XYZ 120-3 (0.6) 120-4 (0.1) - 120-4 (0.1) - 120-4 (0.1) - 120-6 (0.5) - 120-1 (0.2) 120-2 (0.1) 120-3 (0.1) • • • 120-5 (0.1) 120-4 (0.2) 120-2 (0.1) -
120-1 42 E->W (35.5,-105) ROAD XYZ 120-2 (0.8)
120-4 42 S->N (48.3,-97.3) ROAD XYZ 120-5 (0.7)
120-4 45 N->S (48.3,-97.3) ROAD XYZ
• • •
120-5 32 E->W (43.6,-96.7) ROAD XYZ

FIG. 3

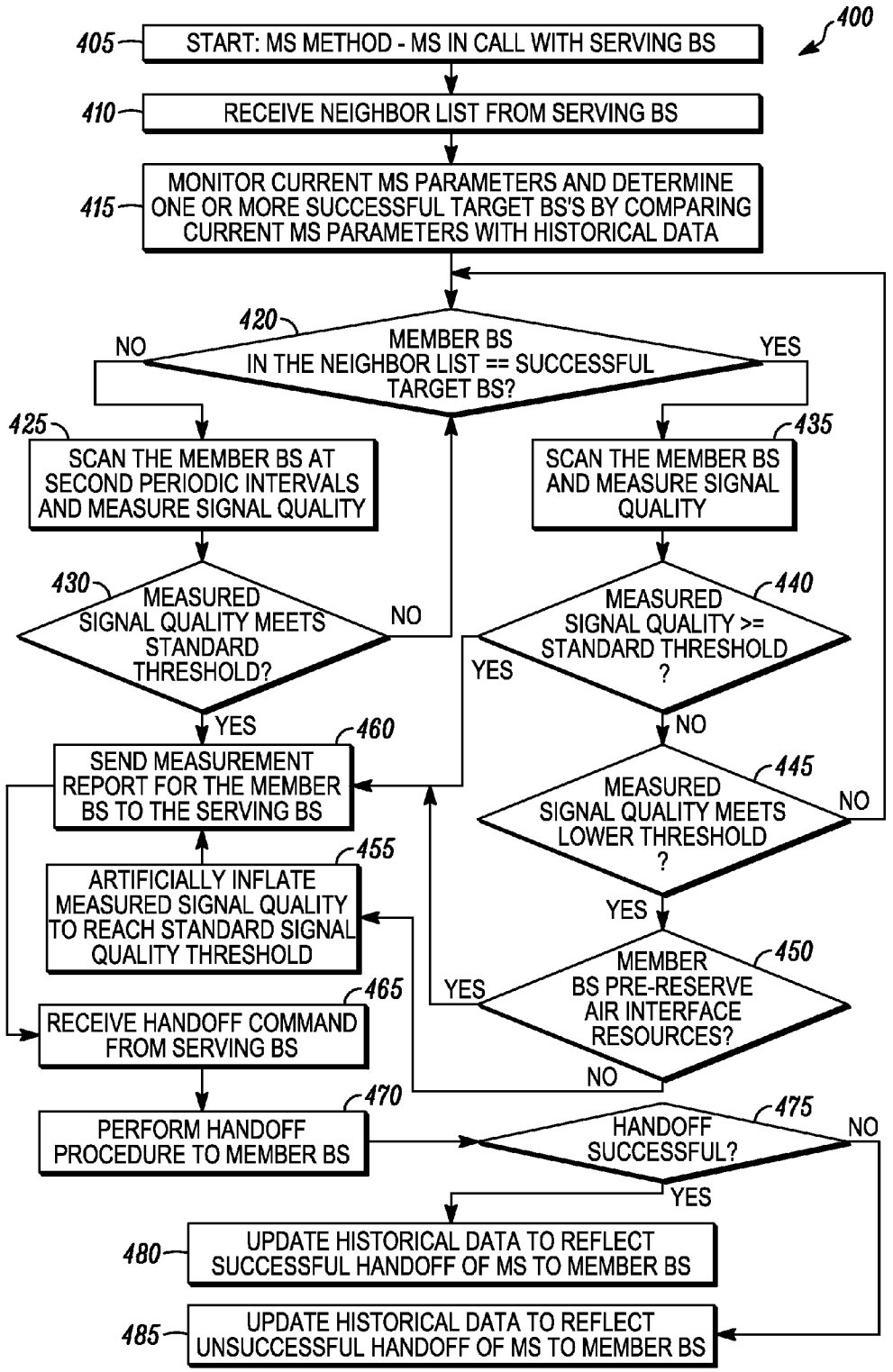

400
405
START: MS METHOD - MS IN CALL WITH SERVING BS
410
RECEIVE NEIGHBOR LIST FROM SERVING BS
415
MONITOR CURRENT MS PARAMETERS AND DETERMINE ONE OR MORE SUCCESSFUL TARGET BS'S BY COMPARING CURRENT MS PARAMETERS WITH HISTORICAL DATA
420
MEMBER BS IN THE NEIGHBOR LIST == SUCCESSFUL TARGET BS?
NO
YES
425
SCAN THE MEMBER BS AT SECOND PERIODIC INTERVALS AND MEASURE SIGNAL QUALITY
435
SCAN THE MEMBER BS AND MEASURE SIGNAL QUALITY
430
MEASURED SIGNAL QUALITY MEETS STANDARD THRESHOLD?
NO
YES
440
MEASURED SIGNAL QUALITY >= STANDARD THRESHOLD ?
YES
NO
460
SEND MEASUREMENT REPORT FOR THE MEMBER BS TO THE SERVING BS
445
MEASURED SIGNAL QUALITY MEETS LOWER THRESHOLD ?
NO
YES
455
ARTIFICIALLY INFLATE MEASURED SIGNAL QUALITY TO REACH STANDARD SIGNAL QUALITY THRESHOLD
450
MEMBER BS PRE-RESERVE AIR INTERFACE RESOURCES?
YES
NO
465
RECEIVE HANDOFF COMMAND FROM SERVING BS
470
PERFORM HANDOFF PROCEDURE TO MEMBER BS
475
HANDOFF SUCCESSFUL?
NO
YES
480
UPDATE HISTORICAL DATA TO REFLECT SUCCESSFUL HANDOFF OF MS TO MEMBER BS
485
UPDATE HISTORICAL DATA TO REFLECT UNSUCCESSFUL HANDOFF OF MS TO MEMBER BS

FIG. 4

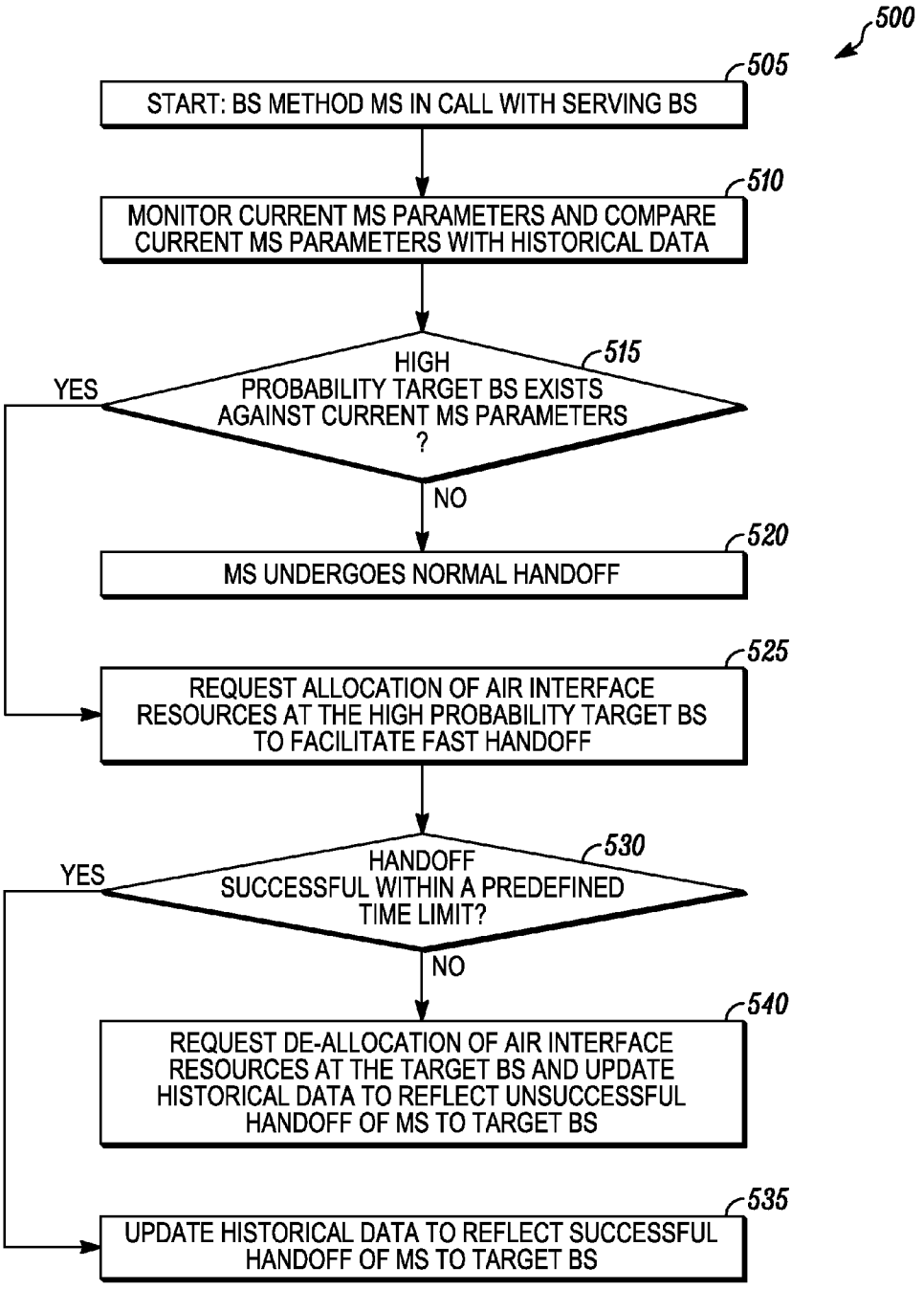

500
505
START: BS METHOD MS IN CALL WITH SERVING BS
510
MONITOR CURRENT MS PARAMETERS AND COMPARE CURRENT MS PARAMETERS WITH HISTORICAL DATA
515
HIGH PROBABILITY TARGET BS EXISTS AGAINST CURRENT MS PARAMETERS ?
YES
NO
520
MS UNDERGOES NORMAL HANDOFF
525
REQUEST ALLOCATION OF AIR INTERFACE RESOURCES AT THE HIGH PROBABILITY TARGET BS TO FACILITATE FAST HANDOFF
530
HANDOFF SUCCESSFUL WITHIN A PREDEFINED TIME LIMIT?
YES
NO
540
REQUEST DE-ALLOCATION OF AIR INTERFACE RESOURCES AT THE TARGET BS AND UPDATE HISTORICAL DATA TO REFLECT UNSUCCESSFUL HANDOFF OF MS TO TARGET BS
535
UPDATE HISTORICAL DATA TO REFLECT SUCCESSFUL HANDOFF OF MS TO TARGET BS

FIG. 5

METHOD OF A SERVING BASE STATION FOR FACILITATING A MOBILE STATION TO PERFORM A FAST HANDOFF

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a divisional of U.S. patent application Ser. No. 11/957,652 entitled "Method for Facilitating a Mobile Station to Perform a Fast Handoff" filed on Dec. 17, 2007 by Lorenzo A. Ponce de Leon et al. and claims the benefit thereof.

FIELD OF THE DISCLOSURE

[0002] The present disclosure relates generally to communication networks, and more particularly to facilitating mobile stations to perform fast handoff in communication networks.

BACKGROUND

[0003] Wireless communications networks, such as mobile wireless telephone networks, have become increasingly prevalent over the past decade. A wireless communication network, such as an infrastructure-based wireless network, typically includes a communication network with fixed and wired gateways. Many wireless networks employ a wireless device or terminal which communicates with a base station that is coupled to a wired network. The wireless device can move geographically while it is communicating over a wireless link to the base station. When the wireless device moves out of range of one base station, it may connect or "handoff" (sometimes called "handover") to a new base station and start communicating with the wired network through the new base station. In order to be ready for a potential handoff, the wireless device may continually background scan for an available base station. Wireless devices have limited energy reserves, however they must actively interface with a network to establish link and transfer data. A network environment in a wireless link is spatial, dynamic, and stochastic. Continually scanning for available base stations may place a strain on the wireless device's energy reserves and increase its power consumption which may further reduce the life span and overall performance of the wireless device.

[0004] In addition, the long latency period associated with the handoff is undesirable for wireless devices as this may prevent running of certain applications and interrupt data transfer between the wireless device and the network. The wireless device therefore expends energy and time in establishing and maintaining links prior to and after data transfers. Multimode wireless devices have the additional problem of covering many bands and interfacing with networks asynchronously, thereby adding additional load to the device's energy resources. In some cases, multimode wireless devices may be "blind" for a period of time to all the network services available at a locale. Accordingly there is a need to facilitate the wireless devices to perform fast handoff while optimizing the energy expenditure associated with establishing and monitoring links in wireless networks.

BRIEF DESCRIPTION OF THE FIGURES

[0005] The accompanying figures, where like reference numerals refer to identical or functionally similar elements throughout the separate views, together with the detailed description below, are incorporated in and form part of the specification, and serve to further illustrate embodiments of concepts that include the claimed invention, and explain various principles and advantages of those embodiments.

[0006] FIG. **1** is a block diagram of a wireless communication system in accordance with some embodiments.

[0007] FIG. **2** is a block diagram of a mobile station in communication with a base station in accordance with some embodiments.

[0008] FIG. **3** is a structure of historical data in accordance with some embodiments.

[0009] FIG. **4** is a flowchart of a method for facilitating a mobile station to perform fast handoff in accordance with some embodiments.

[0010] FIG. **5** is a flowchart of a method for a base station to facilitate a mobile station to perform fast handoff in accordance with some embodiments.

[0011] Skilled artisans will appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions of some of the elements in the figures may be exaggerated relative to other elements to help to improve understanding of embodiments of the present invention.

[0012] The apparatus and method components have been represented where appropriate by conventional symbols in the drawings, showing only those specific details that are pertinent to understanding the embodiments of the present invention so as not to obscure the disclosure with details that will be readily apparent to those of ordinary skill in the art having the benefit of the description herein.

DETAILED DESCRIPTION

[0013] The present invention provides a method for facilitating a mobile station to perform a fast handoff in a wireless communication system. A mobile station is configured to monitor its network environment and store a history of the network environment in memory. The mobile station can use its historical data to minimize the energy spent to establish the parameters of the local network environment. In operation, the mobile station receives a neighbor list from a serving base station. The neighbor list includes a list of base station that may be neighboring to the serving base station and may include both base stations of the current network and base stations of different networks and/or different radio access technologies (RATs). The mobile station then determines whether a member base station of the neighbor list is a "successful" target base station based on historical data (i.e., that handoff to that target base station has previously been successful). If the mobile station determines that the member base station is not a successful target base station, then the mobile station background scans the member base station and measures a signal quality associated with the member base station, and further sends a measurement report for the member base station when the signal quality meets a standard signal quality threshold. In a case when the mobile station determines that the member base station is a "successful" target base station, the mobile station sends the measurement report as soon as the measured signal quality meets a signal quality threshold that is lower than the standard signal quality threshold.

Wireless Communication System

[0014] FIG. **1** is a block diagram illustrating one example of a wireless communication system **100**. The wireless commu-

nication system **100** includes a coverage area divided into a plurality of cells **110-1** through **110-*n***. Each cell **110-*n*** is served by a base station **120-*n***. For example, as shown in FIG. **1**, the cells **110-1**, **110-2**, **110-3**, **110-4**, **110-5**, and **110-6** are served by their respective base stations **120-1**, **120-2**, **120-3**, **120-4**, **120-5**, and **120-6**. Each base station **120-*n*** connects the mobile stations **130-*n*** present in the corresponding cell **110-*n*** with a communication network through a mobile switching center **140**. In the example of FIG. **1**, the mobile stations **130-1** and **130-2** present in the cell **110-1** are served by the base station **120-1**. The mobile switching center **140** can connect the mobile station **130-1** to other networks **150** such as a public switched telephone network (PSTN). As the mobile stations **130-*n*** move geographically across the communication system, the mobile stations **130-*n*** can handoff to different base stations **120** of the wireless communication system **100**. According to some embodiments of the present invention, the mobile stations **130-*n*** are facilitated to perform fast handoff with the base stations **120-*n*** as the mobile stations traverse through the cells **110-*n*** of the wireless communication system **100**. For example, the wireless communication system **100** may facilitate the mobile station **130** to perform fast handoff with each of the base stations **120-1**, **120-4**, and **120-5**, and **120-6** when the mobile station **130-1** traverses through the cells **110-1**, **110-4**, **110-5**, and **110-6** via road XYZ **160** as shown in FIG. **1**.

Components of Mobile Station and Base Station

[0015] Now referring to FIG. **2**, the mobile station **130** is shown in communication with the base station **120**. The mobile station **130** and the base station **120** are in communication with each other through a radio link **205**. The mobile station **130** may be any type of wireless communication device including, but not limited to, cellular, mobile, and wireless telephones; PCs (personal computers), laptop, notebook, and wearable computers with wireless modems, PDAs (personal digital assistants) with wireless modems; and pagers. For example, the mobile station **130** may include digital systems to secure fast wireless transmissions of voice and/or data.

[0016] The base station **120** may be any wireless communication station installed at a fixed location of the wireless communication system **100**. The base station is sometimes referred to as a radio base station or Node B (in 3G networks), or access point base station, or an infrastructure device.

[0017] The mobile station **130** comprises a processor **210**, a transceiver **215** including a transmitter circuitry **217** and a receiver circuitry **219**, an antenna **220**, a memory **225**, a scanner **230**, and the neighbor list report trigger **235**. The base station **120** includes a processor **260**, a transceiver **265** including a transmitter circuitry **267** and a receiver circuitry **269**, an antenna **270** which may be an omni, sector, MIMO, or smart antenna array, and a memory **275**. Although not shown, the base station **120** and the mobile station **130** also can include an antenna switch, duplexer, circulator, or other highly isolative means (not shown) for intermittently providing information packets from the transmitter circuitry **217**, **267** to the antenna **220**, **270** and from the antenna **220**, **270** to the receiver circuitry **219**, **269**. The mobile station **130** or the base station **120** is an integrated unit containing at least all the elements depicted in FIG. **2**, as well as any other elements necessary for the mobile station **130** or the base station **120** to perform its particular electronic function. For example, the mobile station **130** would include a user interface (not shown) including a display, keypad, loudspeaker, and/or microphone. Alternatively, the mobile station **130** or the base station **120** can comprise a collection of appropriately interconnected units or devices, wherein such units or devices perform functions that are equivalent to the functions performed by the elements of the mobile station **130** or the base station **120**.

[0018] The base station **120** stores neighbor list information **277** in the memory **275**. In one embodiment, the neighbor list information **277** includes a list of base stations that are neighboring to the base station **120**. For example, the neighbor list information **277** of base station **120-4** may include base stations **120-1**, **120-2**, **120-3**, **120-5**, and **120-6**. The neighbor list information **277** is periodically transmitted from the base station **120** to the mobile station **130**. The mobile station **130** stores received neighbor list information **227** in the memory **225**. The mobile station **130** may periodically update the received neighbor list information **227** based on the neighbor list information **277** received from the base station **120**.

[0019] The scanner **230** of the mobile station **130** scans the base stations **120** listed in the received neighbor list information **227** when the mobile station **130** is in a background scanning mode, and measures the signal quality associated with the scanned base stations **120**. The neighbor list report trigger **235** triggers a measurement report for a scanned base station as soon as the signal quality associated with the scanned base station meets a signal quality threshold, wherein the signal quality threshold is either a standard signal quality threshold or a lower signal quality threshold. In embodiments of the present invention, the lower signal quality threshold is simply a predetermined threshold that is lower than the standard signal quality threshold.

[0020] The processor **210**, **260** includes one or more microprocessors, microcontrollers, DSPs (digital signal processors), state machines, logic circuitry, or any other device or devices that process information based on operational or programming instructions. Such operational or programming instructions are stored in the memory **225**, **275**. The memory **225**, **275** can be an IC (integrated circuit) memory chip containing any form of RAM (random-access memory) or ROM (read-only memory), a floppy disk, a CD-ROM (compact disk read-only memory), a hard disk drive, a DVD (digital video disc), a flash memory card, external subscriber identity module (SIM) card or any other medium for storing digital information. One of ordinary skill in the art will recognize that when the processor **210**, **260** has one or more of its functions performed by a state machine or logic circuitry, the memory **225**, **275** containing the corresponding operational instructions can be embedded within the state machine or logic circuitry. The operations performed by the processor **210**, **260** and the other elements of the mobile station **130** and the base station **120** are described in detail below.

[0021] The transmitter circuitry **217**, **267** and the receiver circuitry **219**, **269** enable the mobile station **130** and the base station **120** to communicate information packets to and acquire information packets from the base stations **120** or mobile stations **130**, respectively. In this regard, the transmitter circuitry **217**, **267** and the receiver circuitry **219**, **269** include appropriate, conventional circuitry to enable digital or analog transmissions over a wireless communication channel. One of ordinary skill in the art will recognize that most, if not all, of the functions of the transmitter circuitry **217**, **267** and/or the receiver circuitry **219**, **269** can be implemented in a processor, such as the processor **210**, **260**. However, the

processor **210**, **260**, the transmitter circuitry **217**, **267**, and the receiver circuitry **219**, **269** have been artificially partitioned herein to facilitate a better understanding.

[0022] The receiver circuitry **219**, **269** is capable of receiving radio frequency (RF) signals from at least one frequency band using a RAT and optionally multiple frequency bands or RATs. The receiver circuitry **219**, **269** can optionally comprise a first receiver and a second receiver, or one receiver capable of receiving in two or more frequency bands and/or RATs. The transceiver **215**, **265** includes at least one set of transmitter circuitry **217**, **267**. The at least one transmitter **215**, **265** can be capable of transmitting to multiple devices potentially in multiple frequency bands or RATs.

[0023] The antenna **220**, **270** comprises any known or developed structure for radiating and receiving electromagnetic energy in the frequency range containing the wireless carrier frequencies. Even though only one antenna **220**, **270** is shown, any number of antennas may interface with the transceiver **215**, **265**. Thus, the depiction of one antenna **220**, **270** is not meant to be a limitation on an embodiment of the present invention.

Historical Data

[0024] Historical data **229** stored in a mobile station **130** would include at least an identification of the serving base station and the identification of the most likely target base station for handoff. The base station identification could be a BSID, a serial number, or any other identifying number. Historical data **229** in the mobile station **130** may also include current location information, direction of travel, and a history of handoffs and acquired networks associated with the location and/or direction of travel. Historical data **279** may be stored in a base station **120** or elsewhere on the network and would include information similar to historical data **229**. Historical data **229** may also include a list of mobile station identifications, a history of how they have handed off through the network, and may also include information from smart antenna array settings in the base station.

[0025] The mobile station **130** and/or the base station **120** may store its respective historical data **229**, **279** in memory **225**, **275**. In one embodiment, the historical data **229**, **279** may be stored in an infrastructure within the wireless communication system, wherein the infrastructure may be a device other than the base station **120** and the mobile station **130**, and further wherein the historical data **229**, **279** stored in the infrastructure is accessible by the base station **120** and/or the mobile station **130**.

[0026] Referring now to FIG. **3**, an extract of a structure of the historical data **229**, **279** is shown. The historical data **229**, **279** includes information related to past mobile station parameters **310** which are collected during previous operation of the mobile station **130**. The past mobile station parameters **310** include, but are not limited to, a serving base station identification **315**, a speed **320** of the mobility of the mobile station **130**, a direction **325** of the mobility of the mobile station **130**, a location **135** of the mobile station **130**, or one or more roads **335** traversed by the mobile station **130** during the historical visit. The historical data **229**, **279** may further include smart antenna information (not shown). The smart antenna information includes information related to selected antennas from an array of antennas for communication with the base station during historical visits of the mobile station **130**. In one example, the mobile station **130** may select the antenna based on a direction of arrival (DoA) of a signal associated with the serving base station.

[0027] The historical data **229**, **279** may further include a list **340** of "successful" base stations for handoff corresponding to the past mobile station parameters **310** during historical visits of the mobile station **130**.

Weighting Factor

[0028] In one embodiment, each of the successful base stations in the list **340** may be provided a weighting factor, wherein the weighting factor represents a historically-determined success rate of handoff of the particular mobile station **130** to the base stations **120**. For example, whenever the mobile station **130** performs a successful handoff with a target base station stored in the historical data **229**, **279**, then the historical data **229**, **279** is updated to increase the weighting factor associated with the target base station. On the other hand, when the handoff is not successful, then the historical data **229**, **279** can be updated to decrease the weighting factor to reflect the unsuccessful handoff of the mobile station **130** to the target base station. In one implementation of the present invention, the weighting factor associated with the target base station remains unaltered until the mobile station performs a successful handoff with the target base station; and when the mobile station performs a successful handoff with a target base station, the weighting factor associated with the target base station is increased to reflect the successful handoff of the mobile station to the target base station.

[0029] As shown in FIG. **3** and referring to FIG. **1**, according to one example, the historical data **229**, **279** denotes that the mobile station **130-1** has successfully performed handoff with the base station **120-4** with a weighting factor 0.8 as against a weighting factor 0.6 for the base station **120-2**. Therefore, when currently traveling with mobile station parameters that are similar to a past mobile station parameter **310** of (**120-1**, 42, S->N, 35.5, −105, Road XYZ . . .), the mobile station **130-1** is most likely to perform a successful handoff with the base station **120-4** compared to the other base stations **120-*n***. In another example, when currently traveling with mobile station parameters that closely match the past mobile station parameter **310** of (**120-5**, 32, E->W, 43.6, −96.7, Road XYZ . . .), the mobile station **130-1** may prefer handing off to base station **120-4** rather than to base station **120-2**, because, for this particular past mobile station parameter, the weighting factor (0.2) for the base station **120-4** is higher than the weighting factor (0.1) associated with the base station **120-2**.

Flowchart of Mobile Station Method to Facilitate Fast Handoff

[0030] FIG. **4** is a flowchart of a method **400** for facilitating a mobile station **130** to perform fast handoff in accordance with some embodiments. The method **400** begins at step **405**, where a mobile station **130** is in a call with a serving base station **120**. At step **410**, the mobile station **130** receives neighbor list information **227** from the serving base station **120**. Next at step **415**, the mobile station **130** monitors at least one current mobile station parameter and determines one or more successful target base stations by comparing the current mobile station parameters with its historical data **229**. In one example, the mobile station **130** determines one or more successful target base stations by monitoring at least one current mobile station parameter including, but not limited to,

a serving base station identification, smart antenna information, a speed of the mobility of the mobile station **130**, a direction of mobility of the mobile station **130**, a location of the mobile station **130**, and comparing the at least one current mobile station parameter with at least one past mobile station parameter **310** in the historical data **229**. In one embodiment, a historical base station included in the historical data **229** is a successful target base station when a weighting factor associated with the historical base station exceeds a predefined weighting factor, and further when the at least one current mobile station parameter matches the at least one past mobile station parameter **310**. The predefined weighting factor may be different depending on the cell **110**-*n* the mobile station **130** is currently associated with.

[0031] Next at step **420**, the mobile station **130** determines whether a member base station in the received neighbor list information **227** is a (previously) successful target base station. If the member base station is not the successful target base station, then at step **425**, the mobile station **130** background scans the member base station and measures a signal quality associated with the member base station. As can be appreciated by a person of ordinary skill in the art, step **425** is a periodic process and therefore, the mobile station **130** may re-scan the member base station after a first time period interval (T_1). At step **430**, the mobile station **130** determines whether the measured signal quality for the member base station meets the standard signal quality threshold. If the measured signal quality threshold does not meet the standard signal quality threshold, then the mobile station **130** proceeds to determine if a next member base station in the neighbor list **227** is a successful target base station as shown in step **420**. On the other hand, if the mobile station determines that the measured signal quality threshold meets the standard signal quality threshold, then the mobile station **130** proceeds to step **460** and sends a measurement report for the member base station to the serving base station **120**.

[0032] Referring back to step **420**, if the mobile station **130** determines that the member station is a (previously) successful target base station, then at step **435**, the mobile station **130** background scans the member base station and measures a signal quality associated with the member base station. As can be appreciated by a person skilled in the art, step **435** is a periodic process, and therefore, the mobile station **130** may re-scan the member base station after a second time period interval (T_2). In this embodiment, the second time period (T_2) is shorter than the first time period interval (T_1) i.e. $T_2<T1$. Next at step **440**, the mobile station **130** determines whether the measured signal quality threshold meets the standard signal quality threshold. If the measured signal quality threshold meets the standard signal quality threshold, then the mobile station **130** proceeds to step **460** to send a measurement report for the member base station to the serving base station. On the other hand, if the measured signal quality threshold does not meet the standard signal quality threshold, then at step **445**, the mobile station **130** determines whether the measured signal quality threshold meets the lower signal quality threshold. If the measured signal threshold does not meet the lower signal quality threshold, then the mobile station **130** proceeds to step **420** to determine if a next member base station in the neighbor list **227** is a successful target base station.

[0033] Referring back to step **445**, when the mobile station **130** determines that the measured signal quality threshold meets the lower signal quality threshold, then the mobile station proceeds to step **450** to determine whether the member base station is capable of pre-reserving air interface resources. If the member base station is capable of pre-reserving air interface resources, then the mobile station **130** proceeds to step **460** to send a measurement report for the member base station to the serving base station. On the other hand, if the member base station is not capable of pre-reserving air interface resources, then at step **455**, the mobile station **130** artificially inflates the measured signal quality measurement to reach the standard signal quality threshold. Next at step **460**, the mobile station **130** sends the artificially inflated measurement report for the member base station to the serving base station.

[0034] Next at **465**, the mobile station **130** receives a handoff command from the serving base station in response to the measurement report for the member base station. The mobile station **130** then proceeds to step **470** to perform a handoff procedure with the member base station. Next at step **475**, the mobile station **130** determines whether the handoff to the member base station is successful. If the handoff to the member base station is successful, then the mobile station **130** updates the historical data **229** to reflect successful handoff of the mobile station **130** to the member base station. In one example, the mobile station **130** updates the historical data **229** by increasing the weighting factor associated with the member base station. In one embodiment, if the weighting factor associated with a target base station increases beyond an upper weighting factor threshold, then the weighting factor is not increased even if there are subsequent successful handoffs of the member base station to the target base station. On the other hand, if the handoff to the member base station is not successful, then the mobile station **130** updates the historical data **229**, **279** to reflect unsuccessful handoff of the mobile station to the member base station. In one example, the mobile station **130** updates its historical data **229** by decreasing the weighting factor associated with the member base station. In another example, if the weighting factor associated with a target base station decreases below a lower weighting factor threshold, then the weighting factor is not decreased even if there are subsequent unsuccessful handoffs to the target base station.

Flowchart of Base Station Method to Facilitate Fast Handoff

[0035] FIG. **5** is a flowchart of a method **500** for a base station **120** to facilitate a mobile station **130** to perform fast handoff in accordance with some embodiments. The method begins at step **505**, where a mobile station **130** is in a call and served by a base station **120**. At step **510**, the base station **120** monitors current mobile station parameters and compares the current mobile station parameters with its historical data **279**. Next at step **515**, the base station **120** determines whether a high probability target base station exists by comparing the current mobile station parameter(s) with historical mobile station parameters **310**. The high probability target base station would be the target base station with the highest weighting factor and may require the weighting factor to exceed a predefined threshold. In an alternate embodiment, any base stations which have weighting factors that exceed a threshold may be considered a high probability target base station. In one example, the base station **120** determines a high probability target base station by examining at least one of a serving base station identification, smart antenna information, a speed of the mobility of the mobile station **130**, a direction of mobility of the mobile station **130**, or a location

of the mobile station **130**, and comparing the at least one current mobile station parameter with at least one past mobile station parameter **310** in the historical data **279**. If a high probability target base station does not exist for the current mobile station parameter(s), then at step **520**, the base station **120** facilitates the mobile station **130** to undergo normal handoff using standard handoff procedures.

[0036] On the other hand, if the base station **120** determines that a high probability target base station exists for the current mobile station parameter, then the base station **120** anticipates that the mobile station **130** will handoff to the high probability target base station prior to the mobile station **130** reporting reception of signals from the high probability target base station. Next at step **525**, the base station **120** requests allocation of air interface resources at the high probability target base station to facilitate the mobile station **130** to undergo fast handoff with the high probability target base station.

[0037] Next at step **530**, the base station **120** determines whether the handoff of the mobile station **130** to the high probability target base station is successful within a predetermined time period. If the handoff of the mobile station **130** to the high probability target base station is successful within the predetermined time period, the base station **120** updates the historical data **279** to reflect a successful handoff of the mobile station **130** to the high probability target base station. In one example, the base station **120** updates the historical data **279** by increasing the weighting factor associated with the high probability target base station. In one embodiment, if the weighting factor associated with a target base station increases beyond an upper weighting factor threshold, then the weighting factor is not increased even if there are subsequent successful handoffs of the mobile station **130** to the high probability base station. On the other hand, if the base station **120** determines that the handoff of the mobile station **130** to the high probability target base station is not successful within the predefined time period, then at step **540**, the base station **120** requests de-allocation of the air interfaces at the high probability base station and updates the historical data **279** to reflect unsuccessful handoff of the mobile station **130** to the high probability target base station. In one example, the mobile station **130** updates the historical data **229** by decreasing the weighting factor associated with the high probability target base station. In one embodiment, if the weighting factor associated with the high probability target base station decreases below a lower weighting factor threshold, then the weighting factor is not decreased even if there are subsequent unsuccessful handoffs of the mobile station **130** to the high probability target base station.

[0038] Thus, the mobile station is facilitated to perform handoff with a target base station as quickly as possible, thereby reducing the long latency period associated with the handoff. Additionally, by attempting handoff to a target base station that has historically been successful under similar mobile station circumstances, the probability of a dropped call is reduced. Various implementation of the present invention further reduces the strain on the mobile station's energy reserves used for background scanning while optimizing the energy expenditure associated with establishing and monitoring links in wireless networks.

[0039] In implementations where a high probability target base station pre-reserves air interface resources in anticipation of a mobile station being handed off to it, the pre-reservation of air interface resources is offset by a high probability of a handoff procedure completing successfully within a predefined time limit. Without pre-reservation, in some network topographies, a user would experience a dropped call.

[0040] In the foregoing specification, specific embodiments have been described. However, one of ordinary skill in the art appreciates that various modifications and changes can be made without departing from the scope of the invention as set forth in the claims below. Accordingly, the specification and figures are to be regarded in an illustrative rather than a restrictive sense, and all such modifications are intended to be included within the scope of present teachings. The benefits, advantages, solutions to problems, and any element(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential features or elements of any or all the claims. The invention is defined solely by the appended claims including any amendments made during the pendency of this application and all equivalents of those claims as issued.

[0041] Moreover in this document, relational terms such as first and second, top and bottom, and the like may be used solely to distinguish one entity or action from another entity or action without necessarily requiring or implying any actual such relationship or order between such entities or actions. The terms "comprises," "comprising," "has", "having," "includes", "including," "contains", "containing" or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises, has, includes, contains a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element proceeded by "comprises . . . a", "has . . . a", "includes . . . a", "contains . . . a" does not, without more constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that comprises, has, includes, contains the element. The terms "a" and "an" are defined as one or more unless explicitly stated otherwise herein. The terms "substantially", "essentially", "approximately", "about" or any other version thereof, are defined as being close to as understood by one of ordinary skill in the art, and in one non-limiting embodiment the term is defined to be within 10%, in another embodiment within 5%, in another embodiment within 1% and in another embodiment within 0.5%. The term "coupled" as used herein is defined as connected, although not necessarily directly and not necessarily mechanically. A device or structure that is "configured" in a certain way is configured in at least that way, but may also be configured in ways that are not listed.

[0042] It will be appreciated that some embodiments may be comprised of one or more generic or specialized processors (or "processing devices") such as microprocessors, digital signal processors, customized processors and field programmable gate arrays (FPGAs) and unique stored program instructions (including both software and firmware) that control the one or more processors to implement, in conjunction with certain non-processor circuits, some, most, or all of the functions of the method and/or apparatus described herein. Alternatively, some or all functions could be implemented by a state machine that has no stored program instructions, or in one or more application specific integrated circuits (ASICs), in which each function or some combinations of certain of the functions are implemented as custom logic. Of course, a combination of the two approaches could be used.

[0043] Moreover, an embodiment can be implemented as a computer-readable storage medium having computer readable code stored thereon for programming a computer (e.g., comprising a processor) to perform a method as described and claimed herein. Examples of such computer-readable storage mediums include, but are not limited to, a hard disk, a CD-ROM, an optical storage device, a magnetic storage device, a ROM (Read Only Memory), a PROM (Programmable Read Only Memory), an EPROM (Erasable Programmable Read Only Memory), an EEPROM (Electrically Erasable Programmable Read Only Memory) and a Flash memory. Further, it is expected that one of ordinary skill, notwithstanding possibly significant effort and many design choices motivated by, for example, available time, current technology, and economic considerations, when guided by the concepts and principles disclosed herein will be readily capable of generating such software instructions and programs and ICs with minimal experimentation.

[0044] The Abstract of the Disclosure is provided to allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. In addition, in the foregoing Detailed Description, it can be seen that various features are grouped together in various embodiments for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed embodiments require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed embodiment. Thus the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separately claimed subject matter.

We claim:

1. A method of a serving base station for facilitating a mobile station to perform a fast handoff, comprising:

determining a high probability target base station with which the mobile station is most likely to perform handoff based on a historical data;

requesting allocation of air interface resources at the high probability target base station to the mobile station, prior to the mobile station reporting reception of signals from the high probability target base station, to facilitate the mobile station to perform the fast handoff with the high probability target base station.

2. The method of claim **1**, wherein if a handoff procedure with the high probability target base station is successful within a predefined time period, updating the historical data to reflect a successful handoff of the mobile station to the high probability target base station.

3. The method of claim **2**, wherein updating the historical data comprises:

increasing a weighting factor in the historical data associated with the high probability target base station for the mobile station.

4. The method of claim **1**, wherein the determining includes:

examining at least one current mobile station parameter, wherein the at least one current mobile station parameter relates to at least one of: a serving base station identification, smart antenna information, a speed of mobility of the mobile station, a direction of mobility of the mobile station, or a location of the mobile station; and

comparing the at least one current mobile station parameter with at least one past mobile station parameter in the historical data.

5. The method of claim **1**, wherein when a handoff procedure with the high probability target base station is not successful within a predefined time period, updating the historical data to reflect an unsuccessful handoff of the mobile station to the high probability target base station.

6. The method of claim **5**, wherein updating the historical data comprises:

decreasing a weighting factor in the historical data associated with the high probability target base station for the mobile station.

7. The method of claim **5**, further comprising:

requesting de-allocation of air interface resources at the high probability target base station.

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