

CARRIER COMMUNICATION METHOD, PERIPHERAL CELL
MEASUREMENT METHOD, BASIC STATION DEVICE,
AND MOBILE STATION DEVICE

5 TECHNICAL FIELD

[0001]

The present invention relates to a carrier information
notification method and an adjacent cell measuring method
suitable for a mobile communication system in which one or
10 more carrier frequencies are available at each of the cells in
the system.

BACKGROUND OF THE INVENTION

[0002]

15 Mobile communication is actualized making use of radio
frequency carrier signals. In a conventional mobile
communication system, a mobile station (or a mobile
communication device) is measuring the carrier frequency of
adjacent cells to appropriately carry out the handover process
20 when it moves. For example, in widely used Universal Mobile
Telecommunication System (UMTS) or Wideband Code Division
Multiple Access (W-CDMA), the same carrier frequency is used
throughout the cells in the system. Accordingly, a mobile
station is handed over to the same carrier frequency of an
25 adjacent cell when it moves across the cells. In this case,
measurement for adjacent cells is simply carried out at the
same carrier frequency during the handover process.

[0003]

30 However, because frequency availability varies widely
depending on countries, regions, or operators, and because
further globalization is expected in the future, demand for
flexible allocation of multiple carrier frequencies to radio
communications is arising. Meanwhile, international
standardization of Evolved-UMTS Terrestrial Radio Access (E-

UTRA) is currently ongoing, and many studies and discussions are being made to standardize radio interfaces to manage and operate multiple carrier frequencies in a flexible manner. For example, in a system corresponding to E-UTRA, multiple carrier
5 frequencies and signal bandwidths are defined so as to allow base stations or telecommunications carriers to support different carrier frequencies or different signal bandwidths. This means that the number of carrier frequencies, the center frequency of each carrier, and the signal bandwidth will vary
10 among cells laid out by different telecommunications carriers, or among cells managed even by a single telecommunications carrier.

SUMMARY OF INVENTION

15 TECHNICAL PROBLEM TO BE SOLVED [0004]

If the conventional handover technique is applied as it is to a mobile communication system designed to support multiple carrier frequencies, a mobile station (or mobile
20 communication device) has to scan the entire spectrum of the frequency band used by the system for each cell to detect one or more carrier frequencies available in that cell, and measure the propagation condition for each of the detected carrier frequencies. Because a lot of time is required for
25 detection and measurement of carrier frequencies, the workload on the mobile station and the power consumption accompanying the carrier/cell measurement will increase. It is necessary for the mobile station to complete the measurement of the adjacent cells before the reception quality of the signal from
30 the currently connected cell has degraded in order to appropriately carry out the handover process. If the measurement of the adjacent cells takes too much time, the communication quality is degraded, and the link may be cut off depending on the situation.

[0005]

Therefore, it is an objective of the present invention to provide a mobile communication technique that can reduce the measurement workload on a mobile station and achieve effective
5 measurement of adjacent cells to efficiently carry out the handover procedure, with a view to a mobile communication system that supports multiple carrier frequencies.

TECHNICAL SOLUTION

10 [0006]

To solve the above-described problem and achieve the objective, in a mobile communication system to which the present invention is applied, a base station notifies a mobile station located in the cell provided by this base station and
15 communicating with the base station, of carrier information about carrier frequencies available in the system or adjacent cells. The notification (signaling) of the carrier information may be broadcast as a broadcast signal at constant intervals to the entire area of the cell, or it may be transmitted
20 individually to the mobile station before the handover process is started.

[0007]

In a preferred example, the carrier information may include the available carrier frequencies which are to be
25 reported in a rearranged order determined from the degree of congestion of each carrier frequency. Alternatively, the carrier information may include the available carrier frequencies and the determined rank order information.

[0008]

30 The mobile station does not always have to measure all carrier frequencies included in the received carrier information; instead, it may measure only a part of the carrier frequencies in the carrier information. If the propagation condition of the measured carrier frequency is

less than a threshold level, no more measurement is carried out for the rest of the carrier frequencies in the carrier information. Examples of the propagation condition include a received power level, propagation loss, and the received
5 signal-to-interference (thermal noise) power ratio (SIR).
[0009]

In the first aspect of the invention, a carrier information notification method used in a mobile communication system that supports multiple carrier frequencies is provided.
10 The carrier information notification method includes:
(a) at a base station in a cell, generating carrier information about one or more carrier frequencies available at one or more adjacent cells; and
(b) notifying a mobile station located in the cell of the
15 generated carrier information.
[0010]

In a preferred example, the preferential order of measurement of carrier frequencies is determined for the mobile station, and information about the determined
20 preferential order is included in the carrier information.
[0011]

Alternatively, the preferential order of measurement of said one or more adjacent cells may be determined for the mobile station, and such preferential order information may be
25 included in the carrier information.
[0012]

In the second aspect of the invention, an adjacent cell measuring method used in a mobile communication system that supports multiple carrier frequencies is provided. The
30 adjacent cell measuring method includes:
(a) at a mobile station, measuring a first carrier frequency supported by a first adjacent cell; and
(b) if the propagation state of the first carrier frequency satisfies a predetermined condition, measuring a second and

subsequent carrier frequencies supported by the first adjacent cell; and if the propagation state of the first carrier frequency does not satisfies the predetermined condition, finishing the carrier measurement for the first adjacent cell
5 and starting carrier measurement for a second adjacent cell.
[0013]

In the third aspect of the invention, a base station apparatus used in a mobile communication system that supports multiple carrier frequencies is provided. The base station
10 apparatus includes:

- (a) an information acquiring unit configured to acquire information about resource utilization state of each of one or more carrier frequencies available at a cell covered by the base station apparatus and available at adjacent cells;
- 15 (b) a preferential order determination unit configured to determine the preferential order of carrier measurement for measuring said one or more carrier frequencies based on the acquired information; and
- (c) a signal generator configured to generate carrier
20 information including the determined preferential order of the carrier measurement; and
- (d) transmitting the carrier information to a mobile station located in the cell covered by the base station apparatus.
[0014]

25 In the fourth aspect of the invention, a mobile station used in a mobile communication system supporting multiple carrier frequencies is provided. The mobile station includes:

- (a) a receiving unit configured to receive carrier information about one or more carrier frequencies available at each of
30 adjacent cells from a base station that provides a cell in which the mobile station is currently located;
- (b) a measuring unit configured to measure a first carrier frequency among said one or more carrier frequencies available at a first adjacent cell;

(c) a comparison and determination unit configured to compare the measurement result of the first carrier frequency with a predetermined threshold level to determine whether the first carrier frequency satisfies the condition defined by the threshold level; and

(d) a control unit configured to instruct the measuring unit to measure a second carrier frequency available at the first adjacent cell if the first carrier frequency satisfies the condition, and instructs the measuring unit to stop measuring for the first adjacent cell and move to measurement for a second adjacent cell when the first carrier frequency does not satisfy the condition.

ADVANTAGES OF THE INVENTION

[0015]

With the above-described structure, measurement for adjacent cells is carried out efficiently with reduced workload on the mobile station and reduced power consumption during the handover process. When the preferential order is determined for the measurement of carrier frequencies carried out at the mobile station, the efficiencies of adjacent-cell measurement and the handover procedure are further improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG. 1 is a schematic diagram illustrating an example of operations of multiple carrier frequencies.

FIG. 2 is a schematic diagram of a mobile communication system to which the present invention can be applied.

FIG. 3 is a flowchart of narrowing the carrier frequencies to be measured carried out in the mobile communication system shown in FIG. 2.

FIG. 4 illustrates an example of the carrier information generated by and transmitted from the base station to the

mobile station in the mobile communication system of FIG. 2.

FIG. 5 is a block diagram illustrating the first example of the base station apparatus used in the mobile communication systems shown in FIG. 2.

5 FIG. 6 is a block diagram illustrating the second example of the base station apparatus used in the mobile communication system shown in FIG. 2.

FIG. 7 is a block diagram illustrating an example of the mobile station used in the mobile communication system shown
10 in FIG. 2.

LIST OF SYMBOLS

[0007]

- 1-1 current cell
- 15 1-2 adjacent cell(s)
- 10-1.10-2 base station (base station apparatus)
- 12 transmission unit of base station
- 13 multiplexing unit of base station
- 14 transmission signal generator
- 20 15 preferential order determination unit
- 16 resource measuring unit
- 17 transmission buffer
- 18 interface (resource information acquiring unit and resource information reporting unit)
- 25 19 resource management memory
- 20 mobile station (mobile communication device)
- 24 demultiplexing unit
- 25 measurement control unit
- 26 measuring unit
- 30 27 comparison and judgment unit
- 28 handover determination unit
- 29 handover control signal generator
- 30 multiplexing unit of mobile station
- 50 network

BEST MODE FOR IMPLEMENTING THE INVENTION

[0018]

The preferred embodiments of the invention are now
5 described in detail in conjunction with the attached drawings.

[0019]

FIG. 1 illustrates an example of utilization of multiple
carrier frequencies. In this example, three different
frequency bands, the 80 MHz band, the 2 GHz band, and the 5
10 GHz band, are available in the system. In each of the
frequency bands, multiple carrier frequencies can be used. The
band widths of the carrier frequencies in the same band may be
the same or different from one another.

[0020]

15 Since in the conventional technique carrier frequencies
available for a system are fixed and limited within a certain
band, it is unnecessary for a base station to notify the
mobile stations of which carrier frequencies to be used. The
mobile stations can specify the carrier frequencies in advance
20 when measuring adjacent cells. However, in the future flexible
utilization and sharing of carrier frequencies, the mobile
station will have to scan the entire spectrum of each of the
frequency bands to discover the carrier frequencies of the
adjacent cells.

25 To avoid the overload, the base station of each cell
notifies the mobile stations of carrier information about the
adjacent cells in a mobile communication system to which the
present invention is applied. For a spread spectrum system,
the carrier information may be supplied to the mobile stations
30 together with the spread code required for measurement.

[0021]

FIG. 2 is a schematic diagram of a mobile communication
system according to an embodiment of the invention. A mobile
station 20 is currently located in cell 1-1 and communicating

with a base station 10-1. The mobile station 20 is moving toward another cell, and accordingly, carrier frequencies of adjacent cells (cell 1-2, for example) have to be measured. Although only one adjacent cell is illustrated in FIG. 2 for
5 simplification of the figure, there are actually several cells 1-2 existing adjacent to the current cell 1-1.

[0022]

The base station 10-1 notifies the mobile station 20 that, among the carrier frequencies supported by the system, carrier
10 frequencies A, B and C are available at adjacent cell 1-2, to the mobile station 20. Currently, the degree of congestion of the carrier frequencies available in cell 1-2 is highest at carrier C, followed by carriers A and B in this order. In this case, the base station 10-1 may notify the mobile station 20
15 of carrier frequencies B, A and C in this order, beginning at the least congested carrier frequency. If the system employs a code spreading scheme, the spreading code required for the carrier measurement is also reported, together with the carrier information, to the mobile station 20.

20 [0023]

Upon receiving the carrier information, the mobile station 20 carries out carrier measurement only for the carrier frequencies from the notification by base station 10-1, without scanning the entire spectra of the system frequency
25 bands. At this stage, the carrier frequencies to be measured for the adjacent cell are narrowed to some extent. When the preferential order of the carrier frequencies to be measured for the adjacent cell 1-2 is included in the carrier information supplied from base station 10-1, the carrier
30 frequencies to be measured can be further narrowed according to the preferential order.

[0024]

FIG. 3 is a flowchart of the carrier frequency narrowing operations carried out at the mobile station 20. Based on the

carrier information supplied from the base station 10-1,
measurement of carrier frequency B currently at the lowest
congestion level in the adjacent cell 1-2 (in other words, at
the highest preferential order of carrier measurement) is
5 started at the mobile station 20 for the handover process
(S101). Then, based on the measurement result, it is
determined whether the propagation condition of carrier
frequency B satisfies a predetermined condition (S103). If the
predetermined condition is the power level or the signal to
10 interference (thermal noise) ratio of the received signal, it
is determined whether the measured level or value is at or
above a predetermined threshold level or value. If the
predetermined condition is the propagation loss, it is
determined whether the measured value is at or below a
15 predetermined threshold value.
[0025]

If the propagation condition of carrier frequency B is
good, satisfying the predetermined condition (YES in S103),
the rest of the carrier frequencies A and C are measured
20 consecutively, to determine the optimum carrier frequency (or
the optimum combination of carrier frequencies) for
telecommunications (S107). For example, when the carrier
frequencies A and B satisfy the predetermined condition of the
received power level or the received signal to interference
25 (thermal noise) ratio, while carrier frequency C does not
satisfy the condition, then carrier frequencies A and B are
selected as being available in the adjacent cell.
[0026]

If the most preferential carrier frequency B does not
30 satisfy the predetermined condition and is not in good
condition (NO in S103), the measurement for the cell 1-2 is
terminated without conducting further measurement at carrier
frequencies A and C, and measurement for the next adjacent
cell is started (S105).

[0027]

This is because if the most preferential carrier frequency does not satisfy the predetermined condition, it is unlikely that the rest of the carrier frequencies satisfy the required level. This arrangement is applicable to the case in which the preferential order information is not supplied from the base station 10-1, as long as the carrier frequencies A, B and C are in the same frequency band, because the propagation loss is expected to be substantially the same among these carrier frequencies within the same band. By measuring one of the carrier frequencies, it can be speculated that the other carrier frequencies are also in similar propagation conditions. Accordingly, the mobile station 20 measures an adjacent cell focusing on one of the carrier frequencies included in the carrier information supplied from the base station 10-1. If the propagation condition of this carrier frequency is unsatisfactory (without reaching the threshold level), no more measurement at the rest of the carrier frequencies is conducted and the measurement for the focused-on cell is terminated. With this arrangement, the quantity of measurement workload can be reduced.

[0028]

As an alternative, if a carrier frequency that does not satisfy the predetermined threshold level is detected in step S107, the measurement for this adjacent cell may be terminated and the process may be returned to step S105 to move to measurement of the next adjacent cell.

[0029]

FIG. 4 illustrates an example of the carrier information (which example includes adjacent-cell information as well as the preferential order information) supplied from the base station 10-1 to the mobile station 20. In this example, the available carrier frequencies included in the carrier information are rearranged according to the preferential order

determined by the base station 10-1. For the mobile station 20, the cell with the code identification (ID) number 15 is the most preferential cell to access. This cell supports three carrier frequencies, among which carrier frequency B is the most preferential, then carrier frequencies A and C follow in this order. The next most preferential cell is a cell of code identification (ID) number 27, which cell supports only carrier frequency A. Then, the cell with the code ID number 8 is listed, which cell supports carrier frequencies C and D.

10 [0030]

The mobile station 20 acquires the carrier information from the currently connected base station 10-1, and carries out measurement of carrier frequencies in the descending order of preference for each of the adjacent cells, while narrowing the number of carrier frequencies to be measure as illustrated in FIG. 3. When the measurements are finished, the cell to be accessing in the handover process and the carrier frequency used in that cell are selected based on the measurement result.

15 [0031]

20 FIG. 5 is a schematic block diagram of the base station apparatus 10A which corresponds to the base station 10-1 used in the mobile communication system shown in FIG. 2. The base station 10-1 includes an antenna 11, a transmission unit 12, a multiplexing unit 13, a transmission signal generator 14, a preferential order determination unit 15, a resource measuring unit 16, a transmission buffer 17, an interface 18, and a resource management memory 19.

25 [0032]

The transmission unit 12 encodes and modulates a signal to be transmitted, converts the encoded and modulated signal to a radio frequency (RF) signal, and excites the antenna 11 to transmit the RF signal.

30 [0033]

The multiplexing unit 13 multiplexes notification

information generated by the transmission signal generator 14 and transmission data. The notification information generated by the transmission signal generator 14 includes carrier information, and it may be referred to as carrier notification
5 information. The carrier information may include system information and/or adjacent cell information.

[0034]

The preferential order determination unit 15 acquires information about the resource utilization state (or the
10 degree of congestion) of each of the carrier frequencies available in the corresponding cell 1-1 and the adjacent cell 1-2 from the resource management memory 19 via the interface 18 to determine the preferential order of the carrier frequencies.

15 [0035]

The resource measuring unit 16 acquires information about the transmission power level, the number of connected users, the amount of buffered data and so on from the transmission unit 12 and the transmission buffer 17, and estimates the
20 resource utilization state (or the degree of congestion) of each of the carrier frequencies. The transmission buffer 17 buffers transmission data received via the interface from the network. The interface 18 transmits and receives information to and from other base stations (apparatuses) 10-2 or the
25 network. The interface 18 also reports the resource utilization state of the corresponding cell 1-1 to the base station (apparatuses) 10-2 of the adjacent cells 1-2 via the network, and receives the resource utilization state information from the adjacent cells 1-2 via the network.

30 [0036]

The resource management memory 19 stores the resource utilization state information of the base station 10-1, as well as the resource utilization state information of the base station 10-2 of the adjacent cell 1-2 acquired via the

interface 18 from the network.

[0037]

FIG. 6 is a schematic diagram illustrating a second structural example of the base station apparatus 10B corresponding to base station 10-1. In the second example, the resource management memory is not included in the base station 10-1, and instead, it is furnished in the resource management server 40 provided on the network 50. In this case, the resource utilization states of arbitrary cells 1-n (including cells 1-1 and 1-2) are collectively controlled and managed by the resource management server 40. Accordingly, the base station 10-1 acquires the information about the resource utilization state of each of the carrier frequencies of the adjacent cell 1-2 from the resource management server 40 via the network 50. The other components of the base station apparatus 10B are the same as those of the base station apparatus 10A as indicated by the same symbols, and the overlapping explanation for them is omitted.

[0038]

FIG. 7 is a schematic diagram of the mobile station 20 used in the mobile communication system shown in FIG. 2. The mobile station 20 includes at least an antenna 21, a circulator 22, a receiving unit 23, a demultiplexing unit 24, a measurement control unit 25, a measuring unit 26, a comparison and judgment unit 27, a handover determination unit 28, a handover control signal generator 29, a multiplexing unit 30, and a transmission unit 31.

[0039]

The receiving unit 23 demodulates and decodes a received signal (containing carrier notification information) supplied from the base station 10-1 of the current cell 1-1. The demultiplexing unit 24 demultiplexes the received signal into a data component and a control signal component.

[0040]

The measurement control unit 25 designates the spreading code and the carrier frequencies to be measured first at the measuring unit 26 based on the notification information received from the base station 10-1. The measurement control unit 25 also selects the spreading code and the carrier frequencies to be measured next at the measuring unit 26 based on the determination result of the comparison and judgment unit 27. In addition, the measurement control unit 25 designates a threshold value set in the comparison and judgment unit 27. If the threshold value is included in the carrier notification information, then that threshold value may be used. Alternatively, a value set in the measurement control unit 25 may be used as the threshold value.

[0041]

The measuring unit 26 measures the propagation condition for the combination of the spreading code and each of the carrier frequencies designated by the measurement control unit 25.

The comparison and judgment unit 27 compares the carrier measurement result output from the measuring unit 26 with the threshold value designated by the measurement control unit 25, and returns the comparison/judging result to the measurement control unit 25. The comparison and judgment unit 27 and the measurement control unit 25 cooperate to perform the operations shown in FIG. 3 to narrow the number of carrier frequencies to be measured. If the measurement result satisfies the condition defined by the threshold value, and if there is another carrier frequency supported by the currently measured adjacent cell 1-2, then measurement of the next carrier frequency for the same cell is instructed to be performed. If the measurement result does not satisfy the condition given by the threshold value, then the measurement control unit 25 does not instruct further measurement for the currently measured cell, and instructs moving to measurement

for the next adjacent cell.

[0042]

The handover determination unit 28 determines implementation of handover. The handover control signal generator 29 generates a control signal for controlling the handover when it is determined by the handover determination unit 28 that handover can be implemented.

[0043]

The multiplexing unit 30 multiplexes the handover control signal and the transmission data. The transmission unit 31 encodes and modulates the multiplexed signal, and converts the encoded and modulated signal to a radio frequency (RF) signal suitable for transmission from the antenna 21. The circulator 22 allows the antenna 21 to be used in common between signal receiving and signal transmission. The circulator 22 supplies the signal received at the antenna 21 to the receiving unit 23, and supplies the transmission signal output from the transmission unit 31 to the antenna 21.

[0044]

With the above-described structure, the measurement load on the mobile station 20 can be reduced in the multi-carrier or multi-band environment in which multiple carrier frequencies are used in the same frequency band or across different frequency bands. This arrangement leads to prompt measurement of adjacent cells and reduced power consumption during the measurement.

[0045]

When the carrier frequencies to be measured are rearranged in the preferential order, the efficiency of the measurement of adjacent cells and the handover process can be further improved.

[0046]

Although the invention has been described based on the preferred examples, the invention is not limited to these

examples, and many substitutions and alternations are possible for a person with an ordinary skill in the art.

This international patent application claims the benefit of the earlier filing date of Japanese Patent Application No. 5 2005-321540 filed November 4, 2005, and the entire contents of which is incorporated herein by reference.

CLAIMS

1. A carrier frequency notification method used in a mobile communication system that supports multiple carrier
5 frequencies, comprising the steps of:
 at a base station in a cell, generating carrier information about one or more of the carrier frequencies available in each of one or more adjacent cells; and
 notifying a mobile station located in the cell of the
10 generated carrier information.
2. The carrier notification method of claim 1, further comprising the steps of:
15 determining a preferential order of carrier measurement for measuring said one or more of the carrier frequencies at the mobile station; and
 including the preferential order of the carrier measurement in the carrier information and transmitting the
20 carrier information.
3. The carrier notification method of claim 1 or 2, further comprising the steps of:
25 determining a preferential order of cell measurement for measuring said one or more adjacent cells at the mobile station; and
 including the preferential order of the cell measurement in the carrier information and transmitting the carrier
30 information.
4. The carrier notification method of claim 2, wherein the preferential order of the carrier measurement is determined at

the base station, based on a resource utilization state of each of the carrier frequencies available in said cell or said one or more adjacent cells.

5

5. The carrier notification method of claim 3, wherein the preferential order of the cell measurement is determined at the base station, based on a resource utilization state of said cell or said one or more adjacent cells.

10

6. An adjacent cell measuring method used in a mobile communication system that supports multiple carrier frequencies, comprising the steps of:

15 at a mobile station, measuring a first carrier frequency supported by a first adjacent cell; and

 if a propagation condition of the first carrier frequency satisfies a predetermined condition, measuring a second and subsequent carrier frequencies supported by the first adjacent
20 cell, and if the propagation condition of the first carrier frequency does not satisfy the predetermined condition, terminating carrier measurement for the first adjacent cell and moving to carrier measurement for a second adjacent cell.

25

7. The adjacent cell measuring method of claim 6, further comprising the steps of:

 at the mobile station, receiving carrier information about one or more carrier frequencies supported by each of
30 said first and second adjacent cells from a currently connected base station; and

 performing the measurement of the carrier frequencies of the first and second adjacent cells based on the carrier information.

8. The adjacent cell measuring method of claim 7, wherein the carrier information includes preferential order information for carrier measurement performed at the mobile station, and the mobile station performs the measurement of the carrier frequencies of each of the first and second adjacent cells according to the preferential order information of the carrier measurement.

10

9. The adjacent cell measuring method of claim 7, wherein the carrier information includes preferential order information for cell measurement performed at the mobile station, and the mobile station performs the measurement of the carrier frequencies of each of the first and second adjacent cells according to the preferential order information of the cell measurement.

20

10. A base station apparatus used in a mobile communication system that supports multiple carrier frequencies, comprising:

an information acquiring unit configured to acquire information about a resource utilization state of each of one or more carrier frequencies available at a cell of the base station and adjacent cells;

a preferential order determination unit configured to determine a preferential order of carrier measurement for measuring each of said one or more carrier frequencies;

a signal generator configured to generate carrier information including the preferential order of the carrier measurement; and

a transmission unit configured to transmit the carrier information to a mobile station located in the cell of the

base station.

11. The base station of claim 10, further comprising:

5 a resource measuring unit configured to measure the resource utilization state of each of the carrier frequencies available in the cell of the base station; and

 a resource information transmission unit configured to report the measured resource utilization state as resource
10 information to the adjacent cells.

12. A mobile station used in a mobile communication system that supports multiple carrier frequencies, comprising:

15 a receiving unit configured to receive carrier information about one or more carrier frequencies available at each of adjacent cells from a base station in a cell in which the mobile station is currently located;

 a measuring unit configured to measure a first carrier
20 frequency among said one or more carrier frequencies available in a first adjacent cell;

 a comparison and judgment unit configured to compare a measuring result of the first carrier frequency with a threshold value and determined whether the first carrier
25 frequency satisfies a predetermined condition; and

 a controller configured to instruct the measuring unit to measure a second carrier frequency of the first adjacent cell when the first carrier frequency satisfies the predetermined condition and to instruct the measuring unit to terminate the
30 measurement of the first adjacent cell and move to measurement of a second adjacent cell when the first carrier frequency does not satisfy the predetermined condition.

13. The mobile station of claim 12, further comprising:
an handover determination unit configured to determine whether a handover procedure be carried out based on the measurement result of the measuring unit.