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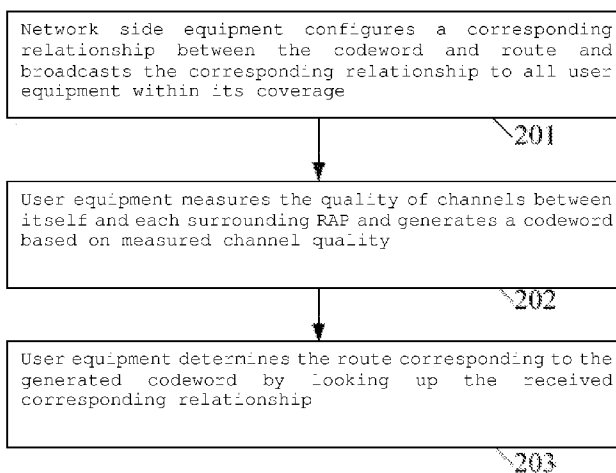


Fig. 2

(57) Abstract: The present invention provides a method for determining routing in a wireless communication network comprising: network side equipment configures a corresponding relationship between a codeword and a route, and broadcasts the corresponding relationship to all user equipment within its coverage; the user equipment measures the quality of channels between itself and each surrounding radio access point to generate a codeword according to the channel quality measured, and determines a route corresponding to the generated codeword by looking up the received corresponding relationship. Additionally, the present further provides a system for determining routing in a wireless communication network, a network side equipment and user equipment. The present invention can quickly determine user equipment routing in a wireless communication network with fewer signaling interactions.

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## Description

Method, System, Network Side Equipment and User Equipment for Determining a Route in a Wireless Communication Network

## Field of Invention

The present invention is directed to routing technology in wireless communication, and more particularly to a method, system, network side equipment and user equipment for determining a route in a wireless communication network.

## Background Technology

In a conventional wireless cellular communication network, user equipment such as subscriber station (SS) and mobile station (MS) directly accesses the base station (BS) in a single hopping manner. However, with rapid development of the wireless communication technology and increasing demand from wireless communication subscribers, the conventional single-hop cellular communication system can no longer meet the increasing subscriber demands due to its inherent defects. For example, as the network traffic and data rate increase, the user equipment in the network must accordingly increase the transmission power or reduce the size of the cellular cell. However, these two measures cannot resolve the underlying problems but rather will increase both interference between subscribers and network investment costs.

To solve these problems, the Institute of Electrical and Electronics Engineers (IEEE) 802.16 proposes a multi-hop cellular architecture where cell coverage is achieved by both the BS and its surrounding relay stations (RS). Fig. 1 is a schematic diagram of a cellular cell using RS. In Fig. 1, RS works with BS as a radio access point to serve SS/MS, and the SS/MS, for example MS1, which is in the proximity of the BS, directly accesses the BS in single-hop manner while SS/MS, for example MS2, which is further away from the BS, accesses the BS in multi-hop manner through one or more RS between itself and the BS. This means that the introduction of RS will not only

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widen both cell coverage and cell capacity but will also reduce the transmission power on the SS/MS side, and thus achieve high quality wireless communication at a low cost.

The routing technology is a key technology in multi-hop cellular communication network. In multi-hop cellular communication networking, when an SS/MS changes its location or the wireless environment changes, the SS/MS needs to adjust its routing, that is, making routing changes, to ensure stable, reliable network service. When the SS/MS changes its routing, how to quickly determine the routing with as few signaling interactions as possible is a problem to be addressed quickly.

The existing route determination solution is typically as the following: SS/MS receives the broadcast message from each RAP in real-time fashion and measures the quality of channels between itself and each RAP, and then send an access request to the RAP with the best measured channel quality; RAP receives the access request from the SS/MS and returns the access information to BS, which makes a final decision on whether to allow the SS/MS to access the RAP.

This means that in the existing route determination solution there are several signaling interactions between SS/MS, RAP and BS and the whole process is complicated and laborious, and is very likely to cause long delays.

#### Description of the Invention

In view of this, the main purpose of the present invention is to provide a method for determining routing in a wireless communication network to have a quick determination of user equipment routing.

To this end, the present invention provides a method for determining routing in a wireless communication network, comprising:

network side equipment configures a corresponding relationship between a codeword and a route and sends the corresponding relationship to user equipment within its coverage;

user equipment measures the quality of channels between

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itself and each surrounding radio access point to generate a codeword according to the channel quality measured, and determines a route corresponding to the generated codeword by looking up the corresponding relationship.

In the present invention, the network side equipment may send the corresponding relationship between the codeword and route to all user equipment or only to the relevant portion of the user equipment. The sending method can be broadcast, multicast or point-to-point.

Wherein the corresponding relationship is configured by consulting the network side equipment information.

The network side equipment information can be one of current carrying capability of each access point, quality of channels between radio access points and prediction of network service traffic or a combination thereof.

The method further includes updating of the corresponding relationship by network side equipment based on changes in the network side equipment information.

The channel quality measured by the user equipment is any one or any combination of wireless signal strength, signal-to-noise ratio, signal transmission delay and statistic characteristic estimation of channel momentary decline.

The process for the user equipment to generate a codeword based on channel quality measurement result comprises: Presetting a codeword generation algorithm and the user equipment processes the channel quality measurement result acquired based on the preset codeword generation algorithm and generates a codeword.

The codeword generation algorithm can be a vector quantification algorithm.

The method may further comprise: the network side equipment allocates an identifier to the corresponding relationship and sends (for example, broadcast or multicast) the corresponding relationship along with the identifier to the related user equipment within its coverage.

After the user equipment determines the route corresponding to the generated codeword by looking up the received

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corresponding relationship, the method further comprises: The user equipment sends an access request to the radio access point corresponding to the determined route and has the identifier of the corresponding relationship carried in the access request.

The method of the present invention may be used in both a multi-hop cellular communication network and a single-hop cellular communication network.

Further, the present invention also provides a system for determining routing in a wireless communication network to have a quick determination of the user equipment routing.

The route determination system comprises network side equipment and user equipment wherein,

the network side equipment comprises:

a configuration unit, for configuring a corresponding relationship between a codeword and a route and sending the configured corresponding relationship to a transceiver unit;

said transceiver unit, for sending the received corresponding relationship to user equipment within the coverage of the network side equipment;

the user equipment comprises:

a channel measurement unit, for measuring the quality of channels between said user equipment and each surrounding radio access point, and sending the measurement result of the channel quality to a codeword generation unit;

said codeword generation unit, for generating a codeword according to the received measurement result of the channel quality, and sending the generated codeword to a route determination unit;

said route determination unit, for receiving the corresponding relationship between the codeword and the route broadcasted by the network side equipment, and determining a route corresponding to the received codeword by looking up the received corresponding relationship.

Wherein said configuration unit may further update said corresponding relationship based on changes in the network side equipment information.

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Said configuration unit may further allocate an identifier to said corresponding relationship and send the identifier to the transceiver unit;

said transceiver unit sends the received identifier to the user equipment within the coverage of the network side equipment.

Said route determination unit may further receive the identifier of the corresponding relationship from the network side equipment and send an access request to the radio access point corresponding to the determined route with the identifier of the corresponding relationship carried in the access request.

In addition, the present invention also provides network side equipment for determining routing in a wireless communication network to configure routing information for the user equipment.

The network side equipment comprises:

A configuration unit, for configuring a corresponding relationship between a codeword and a route and sending the configured corresponding relationship to a transceiver unit;

said transceiver unit, for sending out the received corresponding relationship.

Wherein said configuration unit may further update said corresponding relationship based on changes in the network side equipment information.

Said configuration unit may further allocate an identifier to said corresponding relationship and send the identifier to the transceiver unit; said transceiver unit in turn sends out the received identifier.

Finally, the present invention also provides user equipment for determining routing in a wireless communication network wherein the user equipment quickly determines its route by consulting the routing information broadcasted by the network side equipment.

The user equipment comprises:

a channel measurement unit, for measuring the quality of channels between said user equipment and each surrounding radio

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access point, and sending the measurement result of the channel quality to a codeword generation unit;

the codeword generation unit, for generating a codeword according to the received measurement result of the channel quality, and sending the generated codeword to a route determination unit;

said route determination unit, for receiving the corresponding relationship between the codeword and the route broadcasted by the network side equipment, and determining a route corresponding to the received codeword by looking up the received corresponding relationship.

Said route determination unit may further receive the identifier of the corresponding relationship from the network side equipment and send an access request to the radio access point corresponding to the determined route with the identifier of the corresponding relationship carried in the access request.

From the above it can be seen that in the present invention, the corresponding relationship between the codeword and route is obtained through calculation by the network side equipment by taking into account various factors and is sent to the user equipment. The user equipment which needs to make a routing change will only need to execute a simple codeword generation algorithm and then simply look for the corresponding route in the corresponding relationship broadcasted by the network side equipment based on the generated codeword. The method eliminates the need to make complicated routing calculation and can quickly determine the user equipment routing with fewest possible signaling interactions and low demand on the processing capability of the user equipment. Furthermore, as the corresponding relationship is obtained through calculation by the network side equipment by taking into account of various factors, the route obtained by the user equipment though looking up the corresponding relationship sent from the network side equipment is also the most suitable one. Further in the present invention, the network side equipment can control the behavior of user equipment routing or re-

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routing by simply changing the route corresponding to the codeword.

#### Description of the Drawings

The following will describe the exemplary embodiments of the present invention by consulting the drawings to allow those of ordinary skill in the art to have a better understanding of the above and other characteristics and benefits of the present invention. In the drawings:

Fig. 1 is a schematic diagram of a cellular cell using RS of the prior art;

Fig. 2 is a flowchart depicting the method of route determination of the present invention;

Fig. 3 is a schematic diagram of the system structure for route determination of the present invention.

#### Embodiments

To make the objectives, technical solution and benefits of the present invention clearer and more apparent, the following will give a further detailed description of the present invention through consultation of drawings and embodiments.

Fig. 2 is a flowchart depicting the method of route determination of the present invention. Consulting Fig. 2, the method mainly includes the following steps:

Step 201: Network side equipment configures a corresponding relationship between a codeword and a route and sends the corresponding relationship to all user equipment within its coverage;

Step 202: The user equipment measures the quality of channels between itself and each surrounding radio access point (RAP) and generates a codeword based on the measurement result of channel quality;

Step 203: The user equipment determines the route corresponding to the generated codeword by looking up the received corresponding relationship.

In other words, the user equipment can determine the route without having to make complicated routing calculation when it



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makes routing change. It only needs to look for the route corresponding to the generated codeword in the corresponding relationship sent from the network side equipment. The specific routing decision-making is completed not by the user equipment but by the network side equipment.

Wherein the network side equipment can be a base station (BS), relay station (RS) or radio network controller (RNC); the user equipment can be the equipment used by subscribers such as the subscriber station (SS) or mobile station (MS); RAP can BS or RS.

The codeword is mainly used to define a range. The corresponding relationship between the codeword and route means specifically the corresponding relationship between the range defined by the codeword and the best routing when the user equipment falls within the range defined by the codeword.

For example, the coverage of the network side equipment is divided into four areas, Area A, Area B, Area C and Area D and the route corresponding to these four areas is set to RAP1, RAP2, RAP3 and RAP4. In other words, when the user equipment is in Area A, the network side equipment will route the user equipment to RAP1; when the user equipment is in Area B, the network side equipment will route the user equipment to RAP2; when the user equipment is in Area C, the network side equipment will route the user equipment to RAP3; when the user equipment is in Area D, the network side equipment will route the user equipment to RAP4. Here, the corresponding relationship between the codeword and route is present as the corresponding relationship between the areas and RAPs.

To ensure the route allocation is reasonable, the network side equipment will consider various information of the network side equipment when it configures the corresponding relationship between the codeword and route. The network side equipment information can be any one or any combination of current carrying capability of each RAP, quality of channels between RAPs and prediction of network service traffic. For example, when an RAP has reached its maximum carrying capacity, the network side equipment will no longer route more user

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equipment to that RAP but will elect to route the user equipment to another RAP with a lighter load.

The configuration of the corresponding relationship between the codeword and route may be made in a certain period, that is, the network side equipment makes a configuration at a certain interval.

Wherein the channel quality measured by the user equipment is any one or any combination of wireless signal strength, signal-to-noise ratio, signal transmission delay between the user equipment and RAP and statistic characteristic estimation of channel momentary decline.

The codeword generation algorithm based on channel quality measurement result used by the user equipment can be written into the user equipment when the equipment is produced or be set in the subsequent use of the equipment. When the user equipment determines its route, it processes the channel quality measurement result obtained based on the preset codeword generation algorithm, e.g. vector quantification algorithm, and generates a codeword. Wherein, the vector quantification algorithm means that a number of scalar quantity data form a vector which is then quantified as a whole in the vector space to obtain a quantified value. The present invention may use a vector quantification algorithm, for example a Lloyd algorithm.

In the present invention, the network side equipment and user equipment must use the same codeword generation algorithm. As the user equipment has only limited processing capability, the codeword generation algorithm used should be as simple as possible in order to reduce complexity and to lower the requirement for the processing capability of the user equipment.

Additionally, in order to adapt to any changes in the actual network environment, e.g. when the network side equipment obtains more information about the user equipment behavior, it can self-adaptively update the corresponding relationship between the codeword and route based on the changes in the network side equipment information, that is,

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makes changes to the original route corresponding to the codeword to further ensure that the routing is reasonably developed.

For the convenience of understanding, the following will give a further description of the method of route determination provided by the present invention through a specific embodiment.

For example, we assume that there are three RAPs, i.e. BS, RS1 and RS2, in the coverage of the network side equipment. The network side equipment can use the codeword to represent the quality of channels between the user equipment and RAPs and configure a route for each codeword to set up a route table containing the corresponding relationship between the codeword and route, and then send the route table by broadcasting to all SS/MS within its coverage.

For example, consulting the routing table shown in Table 1, 001 represents the best quality channel between the user equipment and BS; 010 represents the best quality channel between the user equipment and RS1; and 011 represents the best quality channel between the user equipment and RS2.

Codeword	Route
001	BS
010	RS1
011	RS2

Table 1

When MS1 needs to make route changes and if the measured quality of channels between MS1 and BS, RS1 and RS2 is S1, S2 and S3, then MS1 can quantify these data and select a route based on the codeword generated after the quantification.

For example, when  $S1 \geq S2$  and  $S1 \geq S3$ , a codeword of 001 will be generated; when  $S2 > S1$  and  $S2 > S3$ , a codeword of 010 will be generated; when  $S3 > S1$  and  $S3 > S2$ , a codeword of 011 will be generated. If a codeword of 010 is generated after quantification, MS1 will recognize by looking up Table 1 broadcasted by the network side equipment that it should select to connect to RS1.

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For the convenience of understanding, this is just an exemplary description of the range defined by the codeword by simply comparing the numerical value of S1, S2 and S3. It should be noted that in actual application, the range defined by a codeword is very likely to involve a more complicated relationship between S1, S2 and S3. Under a given system performance requirement, the codeword and its corresponding best defined range can be obtained by a vector quantification algorithm.

It should be understood that the codeword may be presented in other ways than binary numerals as shown in Table 1, for example decimal numerals, letters, etc.

When MS1 has determined the route and is ready to access RS1, it should have the information about the selected route, i.e. RS1 information, carried in the access request before sending the request.

Furthermore, the network side equipment may further allocate an identifier to the route table and broadcast the route table along with the identifier to all user equipment within its coverage.

For example, the network side equipment allocates No.1 to the first route table broadcasted and then increases by increments the numbering of subsequent route tables as updated and sent. Upon receiving the route table broadcasted by the network side equipment, the user equipment first compares the corresponding numbering of the route table currently received and that of the route table previously received and saved and determines whether the route table currently received is updated. If yes, it will save the current route table and determine a route based on the information in the route table; otherwise it will directly discard the route table without saving it.

Further, the network side equipment may also have the spatial and geographical information carried in the identifier of the route table and send the route table to the user equipment. For example, the length of the identifier allocated to the route table by the network side equipment is 4, wherein,

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the first 3 digits stand for the numbering of the route table and the last digit stands for the spatial location. The user equipment can obtain the information of its current location based on the last digit of the identifier.

When the user equipment determines the route and sends an access request to the selected RAP, it may further have the identifier of the route table carried in the access request before sending the request to RAP. In this way, the network side equipment will know which route table the user equipment refers to.

To work with the route determination method of the present invention, a system for determining routing in a wireless communication network is also provided. Consulting Fig.3, the system mainly includes: network side equipment and user equipment.

Wherein the network side equipment comprises a configuration unit and a transceiver unit. The configuration unit is used to configure the corresponding relationship between the codeword and route and send the configured corresponding relationship to the transceiver unit; the transceiver unit is used to send the received corresponding relationship to part or all of the user equipment within the coverage of the network side equipment.

The user equipment comprises a channel measurement unit, a codeword generation unit and a route determination unit. The channel measurement unit is used to measure the quality of channels between the user equipment and each surrounding radio access point and send the acquired channel quality measurement result to the codeword generation unit; the codeword generation unit is used to generate a codeword based on the received channel quality measurement result and send the generated codeword to the route determination unit; the route determination unit is used to receive the corresponding relationship between the codeword and route sent from the network side equipment and determine a route corresponding to the received codeword by looking up the corresponding relationship received.

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Wherein said configuration unit may be further used to update said corresponding relationship based on changes in the network side equipment information.

In addition, said configuration unit may further allocate an identifier to said corresponding relationship and send the identifier to the transceiver unit; said transceiver unit in turn sends the received identifier to all user equipment within the coverage of the network side equipment.

Said route determination unit may be further used to receive the identifier of the corresponding relationship from the network side equipment and send an access request to the radio access point corresponding to the determined route with the identifier of the corresponding relationship carried in the access request.

Furthermore, the present invention also provides network side equipment and user equipment for determining a route in a wireless communication network and they have a structure the same or similar to the network side equipment and user equipment shown in Fig. 3 and will not be further described herein.

The above gives a further description of the purposes, technical solutions and benefits of the present invention. It should be understood that they are not intended to limit the present invention and any modifications, equivalent substitutions and improvements without departure from the spirit and principle of the present invention should be within the coverage of the present invention.

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### Claims

1. A method for determining a route in a wireless communication network, comprising:  
network side equipment configures a corresponding relationship between a codeword and a route and sends the corresponding relationship to user equipment within its coverage;  
the user equipment measures the quality of channels between itself and each surrounding radio access point to generate a codeword according to the channel quality measured, and determines a route corresponding to the generated codeword by looking up the corresponding relationship.
2. The method as claimed in claim 1, characterized in that said corresponding relationship is configured by consulting the network side equipment information.
3. The method as claimed in claim 2, characterized in that said network side equipment information is any one or any combination of current carrying capability of each radio access point, quality of channels between radio access point and predication of network service traffic.
4. The method as claimed in claim 3, characterized in that said method further comprises network side equipment updates said corresponding relationship based on changes in the network side equipment information.
5. The method as claimed in claim 1, characterized in that the channel quality measured by said user equipment is any one or any combination of wireless signal strength, signal-to-noise ratio, signal transmission delay, and statistic characteristic estimation of channel momentary decline.

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6. The method as claimed in claim 1, characterized in that the steps for said user equipment to generate the codeword based on measured channel quality comprise:  
Presetting a codeword generation algorithm, and the user equipment processing the acquired channel quality measurement result according to the preset codeword generation algorithm to generate a codeword.
7. The method as claimed in claim 6, characterized in that said codeword generation algorithm is a vector quantization algorithm.
8. The method as claimed in claim 1, characterized in that said method further comprises:  
Network side equipment allocates an identifier to said corresponding relationship and broadcasts said corresponding relationship along with the identifier to all user equipment within its coverage.
9. The method as claimed in claim 8, characterized in that after said user equipment determines the route corresponding to the codeword generated by the user equipment itself by looking up the received corresponding relationship, the method further comprising:  
The user equipment sends an access request to the radio access point corresponding to the determined route and has the identifier of said corresponding relationship carried with the access request.
10. The method as claimed in claims 1 through 9, characterized in that said method is applicable to both a multi-hop cellular communication network and a single-hop cellular communication network.
11. A system for determining routing in a wireless communication network comprising network side equipment and user equipment, characterized in that:



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said network side equipment comprises:

a configuration unit, for configuring a corresponding relationship between a codeword and a route and sending the configured corresponding relationship to a transceiver unit;

said transceiver unit, for sending the received corresponding relationship to user equipment within the coverage of the network side equipment;

the user equipment comprises:

a channel measurement unit, for measuring the quality of channels between the user equipment and each surrounding radio access point, and sending the measurement result of the channel quality to a codeword generation unit;

the codeword generation unit, for generating a codeword according to the received measurement result of the channel quality, and sending the generated codeword to a route determination unit;

said route determination unit, for receiving the corresponding relationship between the codeword and the route broadcasted by the network side equipment, and determining a route corresponding to the received codeword by looking up the received corresponding relationship.

12. The system as claimed in claim 11, characterized in that said configuration unit further updates the corresponding relationship according to changes in the network side equipment information.
13. The system as claimed in claim 11 or 12, characterized in that said configuration unit further allocates an identifier to the corresponding relationship, and sends the identifier to the transceiver unit; and said transceiver unit sends the received identifier to the user equipment within the coverage of the network side equipment.

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14. The system as claimed in claim 13, characterized in that said route determination unit further receives the identifier of the corresponding relationship broadcasted by the network side equipment, and sends an access request to the radio access point corresponding to the determined route with the identifier of the corresponding relationship carried in the access request.
15. Network side equipment for determining routing in a wireless communication network, comprising:  
a configuration unit, for configuring a corresponding relationship between a codeword and a route and sending the configured corresponding relationship to a transceiver unit;  
said transceiver unit, for sending out the received corresponding relationship.
16. The network side equipment as claimed in claim 15, characterized in that said configuration unit further updates said corresponding relationship according to changes in the network side equipment information.
17. The network side equipment as claimed in claim 15 or 16, characterized in that said configuration unit further allocates an identifier to the corresponding relationship, and sends the identifier to the transceiver unit;  
the transceiver unit further sends out the received identifier.
18. User equipment for determining routing in a wireless communication network, characterized in that it comprises:  
a channel measurement unit, for measuring the quality of channels between said user equipment and each surrounding radio access point, and sending the measurement result of the channel quality to a codeword generation unit;  
said codeword generation unit, for generating a codeword according to the received measurement result of the

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channel quality, and sending the generated codeword to a route determination unit;

said route determination unit, for receiving the corresponding relationship between the codeword and the route broadcasted by the network side equipment, and determining a route corresponding to the received codeword by looking up the received corresponding relationship.

19. The user equipment as claimed in claim 18, characterized in that said route determination unit further receives the identifier of the corresponding relationship from the network side equipment, and sends an access request to the radio access point corresponding to the determined route with the identifier of the corresponding relationship carried in said access request.

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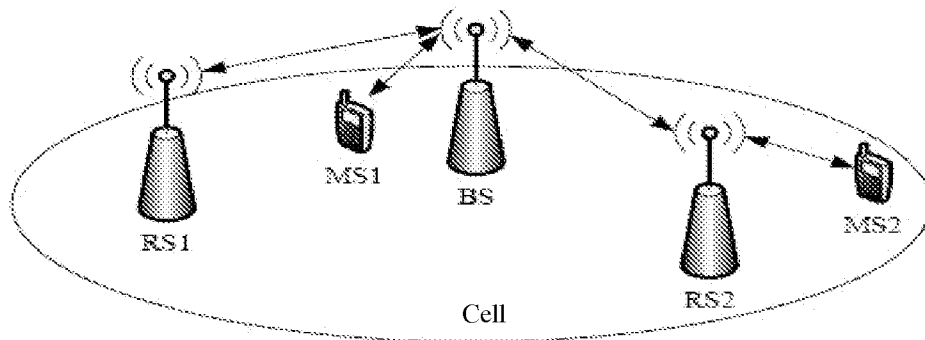


Fig. 1

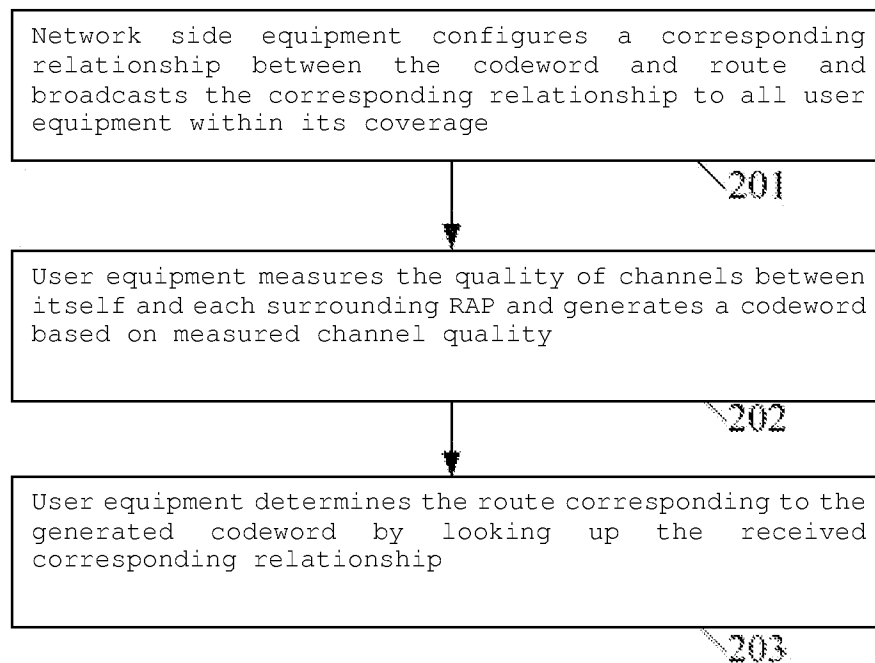


Fig. 2

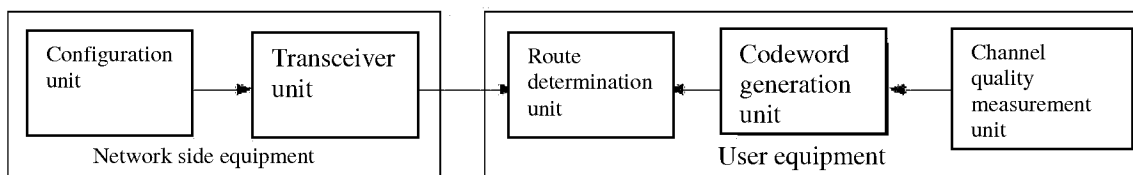


Fig. 3

## INTERNATIONAL SEARCH REPORT

International application No

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## A. CLASSIFICATION OF SUBJECT MATTER

INV. H04L12/56

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 03/077452 A (MESHNETWORKS INC [US]; HASTY JR WILLIAM [US]; STANFORTH PETER [US]) 18 September 2003 (2003-09-18) abstract paragraph [0004] - paragraph [0011] -----	1-19
Y	US 2005/125490 A1 (RAMIA KANNAN B [US] RAMIA KANNAN BABU [IN]) 9 June 2005 (2005-06-09) abstract paragraph [0005] - paragraph [0007] paragraph [0027] - paragraph [0029] ----- -/--	1-19



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# INTERNATIONAL SEARCH REPORT

International application No

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