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(71) Applicant (for all designated States except US): **MIMOS BERHAD** [MY/MY]; Technology Park Malaysia, 57000 Kuala Lumpur (MY).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **AUS, M. Sulaiman** [MY/MY]; c/o Mimos Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY). **SRIDHAR, Sivanand** [MY/MY]; c/o Mimos Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY). **SHARIQ, Haseeb** [MY/MY]; c/o Mimos Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY). **KAMAL, Bahrin Mohd Jamil** [MY/MY]; c/o Mimos Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY). **MOHD, Ar-iff Abdullah** [MY/MY]; c/o Mimos Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY). **MUHAMMAD, Faheem Mohd Ezani** [MY/MY]; c/o Mimos

Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY). **GOPINATH, Rao Sinniah** [MY/MY]; c/o Mimos Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY). **MAZLAN, Abbas** [MY/MY]; c/o Mimos Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY).

(74) Agent: **MIRANDAH, Patrick**; Patrick Mirandah CO. (Malaysia) SDN BHD, Suite 3b-19-3 Plaza Sentral, Jalan Stesen Sentral 5, 50470 Kuala Lumpur (MY).

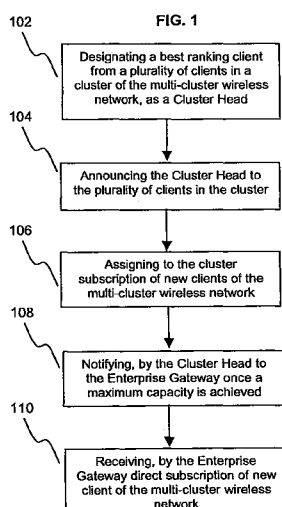
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Declarations under Rule 4.17:

[Continued on next page]

(54) Title: AUTOMATED CLUSTER HEAD MECHANISM IN MULTICAST COMMUNICATION OVER WIRELESS NETWORKS



(57) Abstract: A method for automated cluster head mechanism in multicast communication over a multi-cluster wireless network, comprising designating, by an Enterprise Gateway, a best ranking client from a plurality of clients in a cluster of the multi-cluster wireless network, as a Cluster Head (102), announcing the Cluster Head, by the Enterprise Gateway, to the plurality of clients in the cluster (104) and assigning to the cluster, by the Enterprise Gateway, subscription of new clients of the multi-cluster wireless network (106). The method further comprising notifying, by the Cluster Head to the Enterprise Gateway once a maximum capacity is achieved (108) and receiving, by the Enterprise Gateway direct subscription of new client of the multi-cluster wireless network (110).





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AUTOMATED CLUSTER HEAD MECHANISM IN MULTICAST COMMUNICATION OVER WIRELESS NETWORKS

FIELD OF INVENTION

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The present invention relates generally to a method for automated cluster head mechanism in multicast communication over a multi-cluster wireless network.

BACKGROUND ART

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At present, the requirement for high speed and capacity communication is on a rapid ascent. This is due to the fact that customer demands in the area of multimedia real-time interactive applications as well as Internet Protocol TV (IPTV) are being enhanced for speed and bandwidth.

15

Multicast communication has been proven the most effective mode of transmitting and receiving at high speed and capacity over the present communication infrastructure.

20

However, there are several issues related to multicast communication, the first being, in 802.11 access points, the multicast traffic is treated as a broadcast which reduces the quality of delivered service to the end user. Further, the existing multicast mechanism in 802.11 standards does not provide sufficient bandwidth for a certain multicast traffic such as multimedia or video traffic. Although the use of unicast traffic to stream the traffic to the subscribers guarantees good quality, but it consumes network resources i.e. increases bandwidth utilization and reduces the network scalability.

25

In addition to that, the increment in the number of users is accompanied with an extra load over Enterprise Gateway. Usually the users attach to the access point in a random way, which affects the expected received traffic and any failure occurring in the access point will cause the client to stop receiving the multicast stream.

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SUMMARY OF INVENTION

In one embodiment of the present invention is a method for automated cluster head mechanism in multicast communication over a multi-cluster wireless network. The method
10 comprises designating, by an Enterprise Gateway, a best ranking client from a plurality of clients in a cluster of the multi-cluster wireless network, as a Cluster Head, announcing the Cluster Head, by the Enterprise Gateway, to the plurality of clients in the cluster and assigning to the cluster, by the Enterprise Gateway, subscription of new clients of the multi-cluster wireless network.

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In a further embodiment of the present invention is the method for automated cluster head mechanism in multicast communication over the multi-cluster wireless network. The method further comprises notifying, by the Cluster Head to the Enterprise Gateway once a maximum capacity is achieved and receiving, by the Enterprise Gateway direct subscription of new
20 client of the multi-cluster wireless network.

The present invention consists of features and a combination of parts hereinafter fully described and illustrated in the accompanying drawings, it is being understood that various changes in the details may be made without departing from the scope of the invention or
25 sacrificing any of the advantages of the present invention.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

To further clarify various aspects of some embodiments of the present invention, a more particular description of the invention will be rendered by references to specific embodiments thereof, which are illustrated, in the appended drawings. It is appreciated that these drawings depict only typical embodiments of the invention and are therefore not to be considered limiting of its scope. The invention will be described and explained with additional specificity and detail through the accompanying drawings in which:

- 10 FIG. 1 illustrates a method for automated cluster head mechanism in multicast communication over a multi-cluster wireless network.

FIG. 2 illustrates a method for designating a Cluster Head.

- 15 FIG. 3 illustrates message flow during designating a Cluster Head.

FIG. 4 illustrates message flow during notifying a maximum capacity is achieved in a Cluster Head.

- 20 FIG. 5 illustrates message flow during shutting down of a Cluster Head.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention relates to a method for automated cluster head mechanism in multicast communication over a multi-cluster wireless network. Hereinafter, this specification
5 will describe the present invention according to the preferred embodiments of the present invention. However, it is to be understood that limiting the description to the preferred embodiments of the invention is merely to facilitate discussion of the present invention and it is envisioned that those skilled in the art may devise various modifications and equivalents without departing from the scope of the appended claims.

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The embodiments of the present invention relate to an enhanced method on how to stream multicast traffic using Enterprise Gateway. As defined in the IEEE standards, multicast traffic is treated as a broadcast traffic for 802.11. This infers that any multicast traffic which passes through the Enterprise Gateway will be transmitted at the base data rate because it would be
15 broadcasted on the MAC layer and therefore this affects the quality of the data.

20

According to the method for automated cluster head mechanism of the present invention, firstly a method and system of hierarchical based multicast stream is utilized to organize the Enterprise Network to multi-clusters based on multicast traffic required by each cluster, and assigning a cluster head for each of them.

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Reference is collectively being made to FIGs. 1 and 2. FIG. 1 illustrates a method for automated cluster head mechanism in multicast communication over a multi-cluster wireless network. FIG. 2 illustrates a method for designating, by an Enterprise Gateway, a best ranking client from a plurality of clients in a cluster of the multi-cluster wireless network, as a Cluster Head.

The method for automated cluster head mechanism in multicast communication over the multi-cluster wireless network, comprises the steps of designating, by an Enterprise Gateway, a best ranking client from a plurality of clients in a cluster of the multi-cluster wireless network, as a Cluster Head (102), announcing the Cluster Head, by the Enterprise Gateway, to the plurality of clients in the cluster (104) and assigning to the cluster, by the Enterprise Gateway, subscription of new clients of the multi-cluster wireless network (106). The method further comprises notifying, by the Cluster Head to the Enterprise Gateway once a maximum capacity is achieved (108) and receiving, by the Enterprise Gateway direct subscription of new client of the multi-cluster wireless network (110).

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The method for automated cluster head mechanism in multicast communication over the multi-cluster wireless network of the present invention is an automation process comprising a number of messages, wherein these messages support flexible intercommunication between the Enterprise gateway and the clients or vice versa.

15

The advantages of the automated process comprising the number of messages is the said messages provide an environment to intercommunicate between the clients and the enterprise gateway or vice versa, solicit and assign the most suitable client as the cluster head for its own cluster, notify the clients about the new cluster head and inform the Enterprise Gateway and the clients if any failure occurs to the cluster head. These messages are organized into three modules being the Enterprise Gateway Modules, the Cluster Head Modules and the WiFi client Modules.

20

The Enterprise Gateway Module comprises a multicast module and an application module.

25

The multicast module is responsible for specifying the number of clients per cluster, assign and inform the cluster head, add cluster head's MAC address in the cluster head list table

protocol related messages, forwards the multicast stream to only cluster heads, and rejects subscription requests from non-cluster head clients.

5 The cluster head module comprises a driver module and an application module. The driver module handles only one multicast address, wherein it will have a simplified version of the table including the MAC addresses of the cluster clients. The application module has a socket listening to the Enterprise Gateway, scans the list of open sockets and if it sees a multicast socket, tries to listen at that multicast address and port 10000, when nominated by Enterprise Gateway to be cluster head, it will enable WiFi Access Point and bridge its WiFi
10 station to its WiFi Access Point.

The WiFi Client Module comprises an application module. The application module listens at multicast IP and port number 10000, similar to cluster head, disconnects from Enterprise Gateway and reconnects to cluster head.

15

All the above-mentioned modules intercommunicate and exchange messages defined as CH_FOR_MC_REQ, CH_FOR_MC_RSP, CH_SELECT_NOTIF, CH_SELECT_ACK, CH_SELECT_BCAST, CH_TERM, CH_HELP_REQ and CH_CLOSE. The base line structure of the messages is as follows:

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Type	Length	Data
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wherein, the various fields are defined as:

Type : Type of Message wherein the field size is 2 bytes.

Length : Length of Data wherein the field size is 2 bytes.

25 Data : Optional number of bytes depending on the Data.

The step of designating, by the Enterprise Gateway, the best ranking client from the plurality of clients in the cluster of the multi-cluster wireless network, as the Cluster Head further comprises broadcasting, by the Enterprise Gateway, a capability request to the plurality of clients (202); receiving, by the Enterprise Gateway, a response to the capability request from at least one of the plurality of clients (206), ranking, by the Enterprise Gateway, the at least one of the plurality of clients based on a predetermined parameter to generate a ranking list (208) and handshaking between the Enterprise Gateway and a first best ranking client (210).

The Enterprise Gateway assigns the cluster head based on a list of capabilities such as Virtual Access Point (VAP) creation capabilities and Signal to Noise Ratio (SNR). Besides that, the cluster head is required to intercommunicate and exchange messages as defined.

If no response to the capability request is received by the Enterprise Gateway from the at least one of the plurality of clients, the step of broadcasting, by the Enterprise Gateway, the capability request to the plurality of clients (202) is repeated after a threshold period (204).

If the handshaking between the Enterprise Gateway and the first best ranking client fails, the method further comprises removing the first best ranking client from the ranking list (214); and handshaking between the Enterprise Gateway and a plurality of subsequent best ranking clients (210). If the handshaking between the Enterprise Gateway and the plurality of subsequent best ranking clients fail, the step of designating, by the Enterprise Gateway, the best ranking client from the plurality of clients in the cluster of the multi-cluster wireless network is repeated.

The step of announcing the Cluster Head, by the Enterprise Gateway, to the plurality of

broadcasting an announcement message to the plurality of clients in the cluster to connect to the Cluster Head and performing multicast communication between the Enterprise Gateway and the Cluster Head and the Cluster Head and the plurality of clients in the cluster.

- 5 The step of assigning to the cluster, by the Enterprise Gateway, subscription of new clients of the multi-cluster wireless network further comprises checking, by the Enterprise Gateway, the presence of new clients of the multi-cluster wireless network, informing the new clients, by the Enterprise Gateway, to connect to the Cluster Head and performing multicast communication between the Enterprise Gateway and the Cluster Head and the Cluster Head
10 and the plurality of clients in the cluster.

- The step of notifying, by the Cluster Head to the Enterprise Gateway once the maximum capacity is achieved further comprises checking, by the Cluster Head if the plurality of clients in the cluster has reached the maximum capacity, sending an overwhelming message from
15 the Cluster Head to the Enterprise Gateway and adding, by the Enterprise Gateway, the plurality of clients in the cluster, to the Enterprise Gateway streaming list.

- The step of receiving, by the Enterprise Gateway direct subscription of the new client of the multi-cluster wireless network further comprises checking, by the Enterprise Gateway, the
20 presence of new clients of the multi-cluster wireless network, adding, by the Enterprise Gateway, the new clients in the cluster, to the Enterprise Gateway streaming list and performing multicast communication between the Enterprise Gateway and the new clients.

- The messages for the automated cluster head mechanism of the present invention
25 comprises

- CH_FOR_MC_REQ (0x0001): sent by the Enterprise Gateway to the clients who are keen to receive a particular multicast stream. message is sent to the multicast IP.

- CH_FOR_MC_RSP (0x0002): sent by the capable client to the Enterprise Gateway to show its capability to be cluster head for the particular multicast stream, wherein the length and the data fields are defined as

Length : variable

- 5 Data : own IP address, own MAC address, capability, signal strength, neighbor list if possible by cluster head capable client, wherein the capability is defined as

0x0000 : Cluster head capable

0x0001 : Non-cluster head;

- 10 • CH_SELECT_NOTIF (0x0003): sent by the Enterprise Gateway to the cluster's clients once the most suitable client to be the future cluster head has been decided, sent as a unicast message to the multicast IP, port 10000 and utilizes MAC address for each cluster head, wherein the length and the data fields are defined as

Length : 6 bytes

- 15 Data : MAC address of the particular cluster head;

- CH_SELECT_ACK (0x0004): sent by the Cluster Head to the Enterprise Gateway to confirm if its status is suitable to take this role or it might be in shutting down or failure stage, wherein the length and the data fields are defined as

Length : IPv4 -12 bytes (4 bytes (IP) +6 bytes (MAC) +2 bytes (status))

20 IPv6-24 bytes (12 bytes (IPv6) + 6 bytes (MAC) +2 bytes (status))

Data : own IP address, own MAC address, Status, wherein the status is defined as

Status : 0 - success

More than 0 - failure;

- 25 • CH_SELECT_BCAST (0x0005): sent by the Enterprise Gateway to all clients of particular multicast to the multicast IP, port 10000, to inform them they need to

disconnect from Enterprise Gateway and connect the selected Cluster Head, wherein the length and the data fields are defined as

Length : variable.

Data : Multicast IP address of particular stream, MAC of cluster head (BSSID);

- CH_TERM (0x0006): sent by Cluster Head to Enterprise Gateway or vice-versa (in case of any failure happens during multicast traffic transmission), wherein the length and the data fields are defined as

Length : 8 bytes (6bytes (MAC address) + 2 bytes (Reason))

Data : Cluster Head MAC address, Reason Code;

- CH_HELP_REQ (0x0007): sent by Cluster Head to Enterprise Gateway to indicate that it is overwhelmed with clients, wherein the length and the data fields are defined as

Length : 8 bytes

Data : own MAC address, Reason code;

- CH_CLOSE (0x0008): sent by Cluster Head to clients to indicate that it is shutting down, wherein the length and the data fields are defined as

Length : 6 bytes

Data : MAC address of Enterprise Gateway.

Reference is being made to FIG. 3. FIG. 3 illustrates message flow during designating a Cluster Head. In the initiation stage, when the number of clients for a particular multicast stream reaches the threshold, the Enterprise Gateway sends a (CH_FOR_MC_REQ) message to the clients who are keen to receive a particular multicast stream; this message will be sent to the multicast IP on port 10000. This message will request a cluster head volunteer among the clients in the multicast cluster. The capable client will reply to the

cluster head for the particular multicast stream. In case there are more than one capable client, the Enterprise Gateway will rank the received responses based on the Signal to Noise Ratio (SNR) from the neighbor discovery (ND) list.

- 5 Once the Enterprise Gateway decides on the most suitable client to be the future cluster head, it will send a (CH_SELECT_NOTIF) notification message to the cluster head's MAC address. This notification message will assign the particular client to be the cluster head for the cluster. When the cluster head receive this notification, it will send a (CH_SELECT_ACK) message to the Enterprise Gateway to confirm if its status is suitable to take this role or it
- 10 might be shutting down or is in a failure stage. In case there is failure in the selected cluster head, then the Enterprise Gateway will remove this option from the cluster head list, and choose the second option (if there are any) or repeat the method of designating a Cluster Head from the beginning.
- 15 If the selected cluster head status is a success, the Enterprise Gateway will broadcast a (CH_SELECT_BCAST) announcement message to all clients of particular multicast cluster to inform them to disconnect from Enterprise Gateway and connect to the selected Cluster Head. In this stage, the Enterprise Gateway will build a cluster head address list table, therefore for any multicast cluster, it will check the cluster head address for this particular
- 20 multicast cluster in the table, and it will send this multicast address only to the cluster head. The cluster head will have all the MAC addresses for the cluster clients and it will send the multicast stream to those individual MAC addresses.

- Reference is being made to FIG. 4. FIG. 4 illustrates message flow during notifying a
- 25 maximum capacity is achieved in a Cluster Head. When the Enterprise Gateway receives the announcement of overwhelming from the cluster head, i.e. a (CH_HELP_REQ)

Reference is being made to FIG. 5. FIG. 5 illustrates message flow during shutting down of a Cluster Head. The cluster head will send a (CH_TERM) message to inform the Enterprise Gateway that the Enterprise Gateway should stop sending the multicast stream to it as there has been a sudden failure at the cluster head. The Cluster Head also sends a (CH_CLOSE) message to the clients to inform them that the cluster head is going to shut down. The clients will then refer to Enterprise Gateway to receive the particular multicast stream. In this case the Enterprise Gateway will start the process from the beginning to assign a new cluster head to the multicast cluster.

CLAIMS

1. A method for automated cluster head mechanism in multicast communication over a multi-cluster wireless network, the method comprises

5 designating, by an Enterprise Gateway, a best ranking client from a plurality of clients in a cluster of the multi-cluster wireless network, as a Cluster Head (102);
announcing the Cluster Head, by the Enterprise Gateway, to the plurality of clients in the cluster (104); and
assigning to the cluster, by the Enterprise Gateway, subscription of new clients of
10 the multi-cluster wireless network (106).

2. The method according to claim 1, wherein the method for automated cluster head mechanism in multicast communication over the multi-cluster wireless network further comprises

15 notifying, by the Cluster Head to the Enterprise Gateway once a maximum capacity is achieved (108); and
receiving, by the Enterprise Gateway direct subscription of new client of the multi-cluster wireless network (110).

- 20 3. The method according to claim 1, wherein designating, by the Enterprise Gateway, the best ranking client from the plurality of clients in the cluster of the multi-cluster wireless network, as the Cluster Head further comprises

 broadcasting, by the Enterprise Gateway, a capability request to the plurality of clients (202);
25 receiving, by the Enterprise Gateway, a response to the capability request from at least one of the plurality of clients (206);
 ranking, by the Enterprise Gateway, the at least one of the plurality of clients based on a predetermined parameter to generate a ranking list (208); and

handshaking between the Enterprise Gateway and a first best ranking client (210).

4. The method according to claim 3, wherein the predetermined parameter is Signal to
5 Noise Ratio (SNR).

5. The method according to claim 3, wherein if no response to the capability request is
received by the Enterprise Gateway from the at least one of the plurality of clients,
the method further comprises repeating after a threshold period (204), broadcasting,
10 by the Enterprise Gateway, the capability request to the plurality of clients (202).

6. The method according to claim 3, wherein if the handshaking between the Enterprise
Gateway and the first best ranking client fails, the method further comprises
removing the first best ranking client from the ranking list (214);
15 handshaking between the Enterprise Gateway and a plurality of subsequent
best ranking clients (210); and
if the handshaking between the Enterprise Gateway and the plurality of
subsequent best ranking clients fail, repeating designating, by the Enterprise
Gateway, the best ranking client from the plurality of clients in the cluster of
20 the multi-cluster wireless network.

7. The method according to claim 1, wherein announcing the Cluster Head, by the
Enterprise Gateway, to the plurality of clients in the cluster further comprises
removing, by the Enterprise Gateway, the plurality of clients in the cluster,
25 except the Cluster Head from the Enterprise Gateway streaming list;
broadcasting an announcement message to the plurality of clients in the
cluster to connect to the Cluster Head; and
performing multicast communication between

the Enterprise Gateway and the Cluster Head; and
the Cluster Head and the plurality of clients in the cluster.

8. The method according to claim 1, wherein assigning to the cluster, by the Enterprise Gateway, subscription of new clients of the multi-cluster wireless network further comprises

checking, by the Enterprise Gateway, the presence of new clients of the multi-cluster wireless network;

informing the new clients, by the Enterprise Gateway, to connect to the Cluster Head; and

performing multicast communication between

the Enterprise Gateway and the Cluster Head; and

the Cluster Head and the plurality of clients in the cluster.

9. The method according to claim 2, wherein notifying, by the Cluster Head to the Enterprise Gateway once the maximum capacity is achieved further comprises

checking, by the Cluster Head if the plurality of clients in the cluster has reached the maximum capacity;

sending an overwhelming message from the Cluster Head to the Enterprise Gateway; and

adding, by the Enterprise Gateway, the plurality of clients in the cluster, to the Enterprise Gateway streaming list.

10. The method according to claim 2, wherein receiving, by the Enterprise Gateway direct subscription of the new client of the multi-cluster wireless network further comprises

checking, by the Enterprise Gateway, the presence of new clients of the multi-cluster wireless network;

adding, by the Enterprise Gateway, the new clients in the cluster, to the Enterprise Gateway streaming list; and
performing multicast communication between the Enterprise Gateway and the new clients.

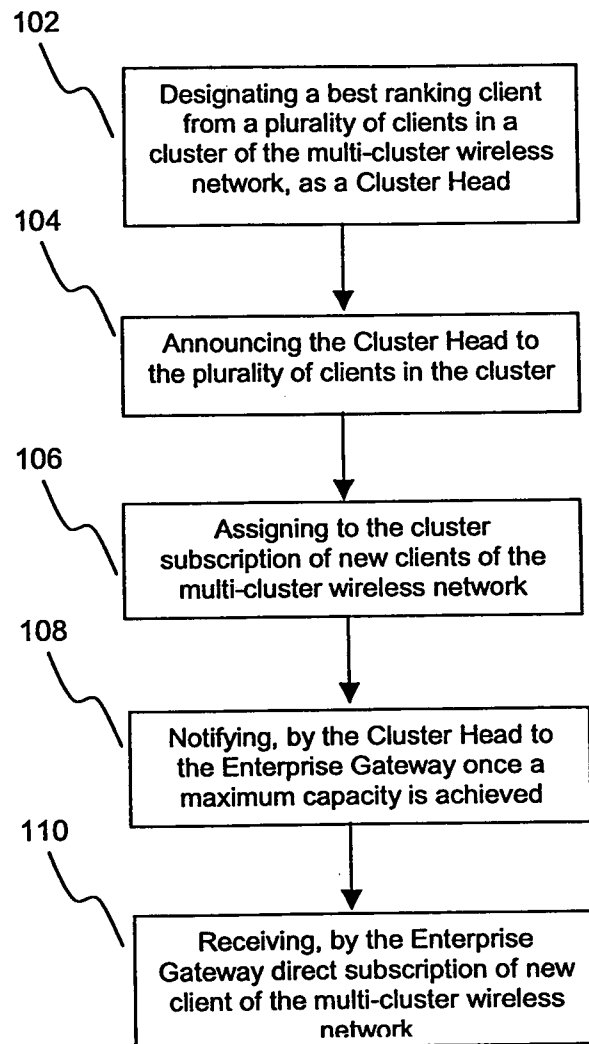
100

FIG. 1

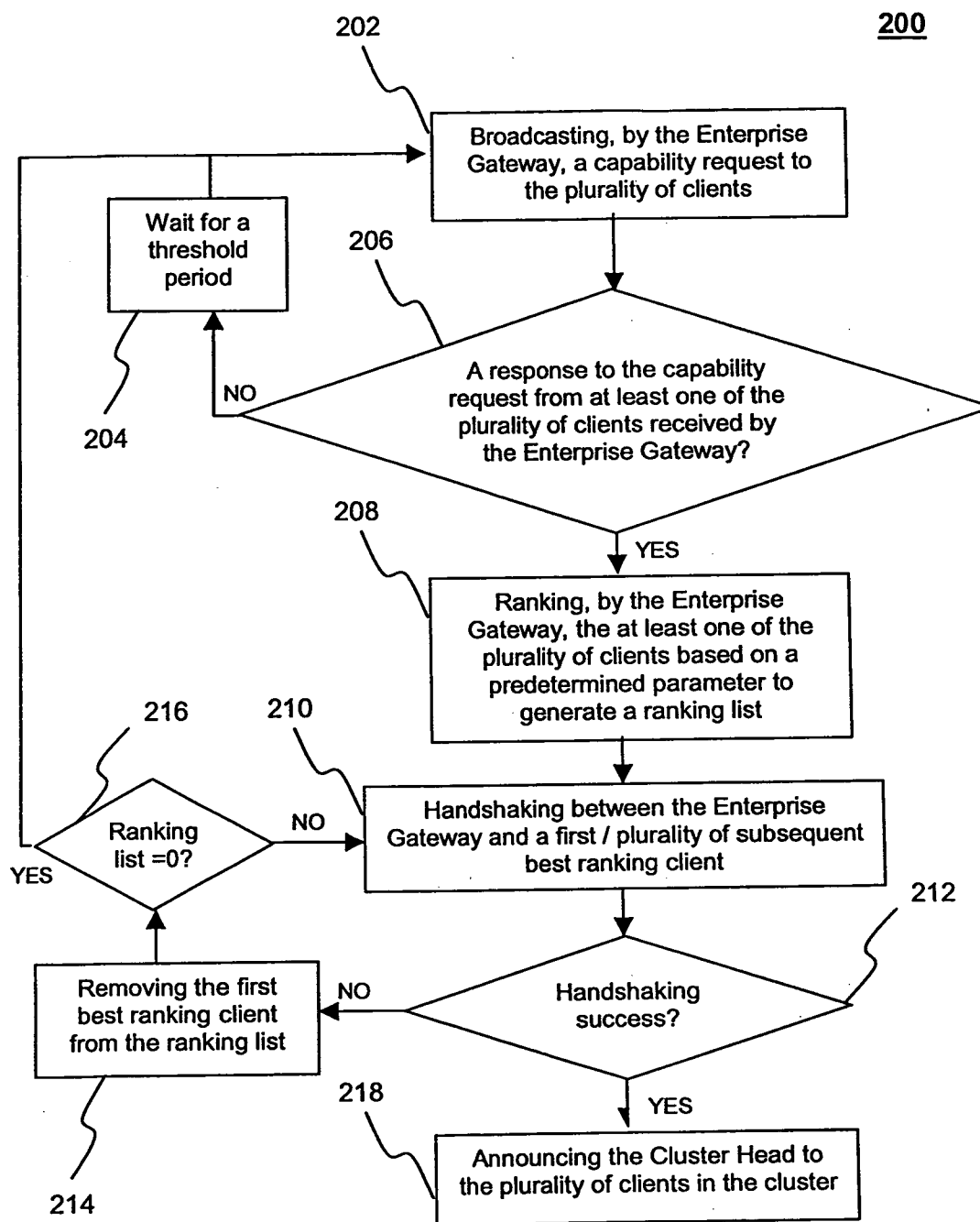


FIG. 2

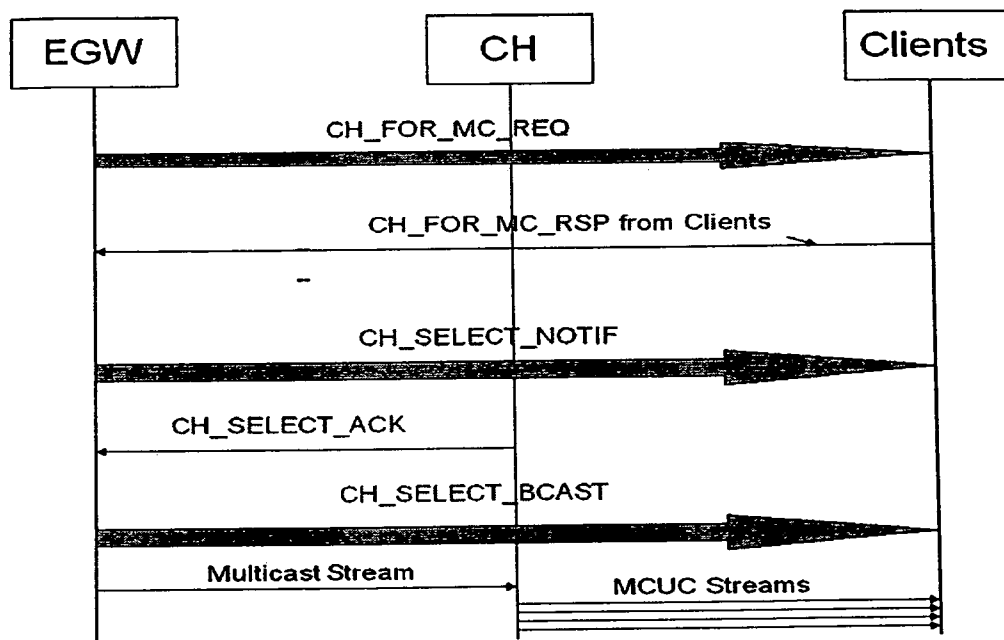


FIG. 3

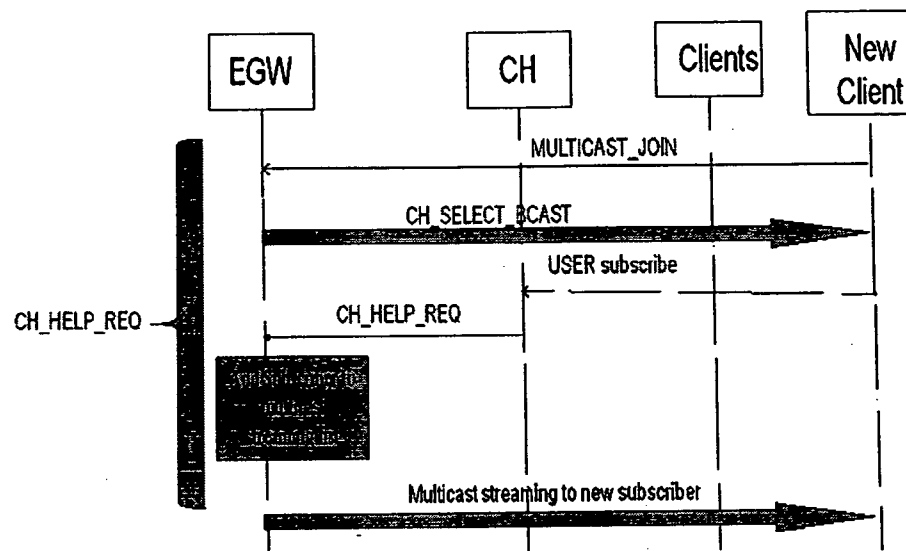


FIG. 4

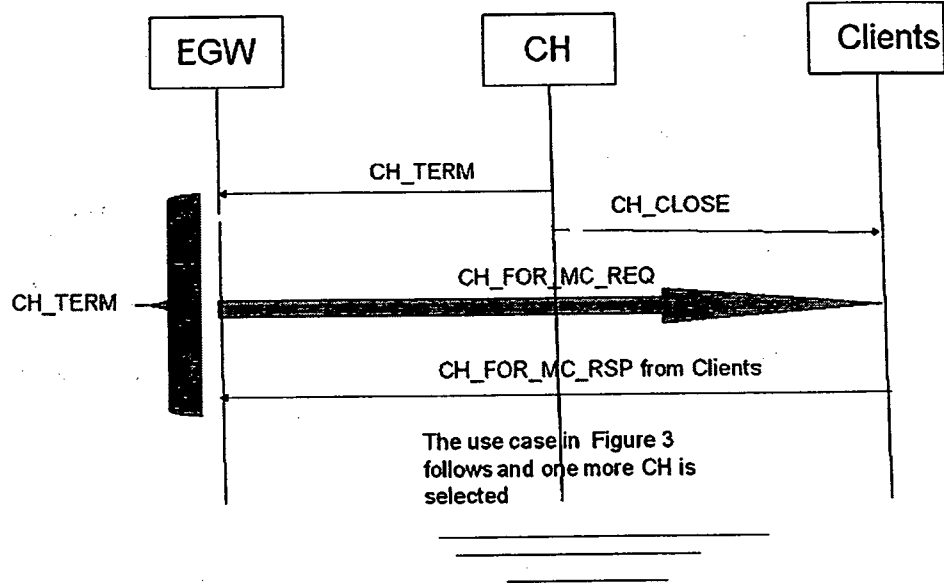


FIG. 5

A. CLASSIFICATION OF SUBJECT MATTER***H04L 12/28(2006.01)i, H04W 84/18(2009.01)i, H04L 12/66(2006.01)i***

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 12/28

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: gateway, multicast, cluster head, subscribe

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	J. ZHOU et al. "Cluster-Based Gateway-Aided Multicast Routing Protocol in MA NET", Wireless Communications, Networking and Mobile Computing, 21 September 2007 See abstract, Sections I, III.	1-10
A	B. SHAN et al. "Border Media Gateway: Extending Multimedia Multicast Gateway to Support Inter-AS Conferencing", International Conference on Communication Technology, 27 November 2006 See the whole document.	1-10
A	X. HONG et al. "Scalable routing protocols for mobile ad hoc networks", IEEE Network, Vol. 16, Issue 4, July 2002 See the whole document.	1-10
A	C. LIN et al. "A Multicast Routing Protocol for Multihop Wireless Networks", IEEE GLOBECOM, 05 December 1999 See the whole document.	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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30 DECEMBER 2010 (30.12.2010)

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Jung Eun Sun

Telephone No. 82-42-481-5708



INTERNATIONAL SEARCH REPORT

Information on patent family members

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