

**Method and System of Wireless Communication Using Master
Carrier Signal**

Field of Invention

5

The present invention relates to a method to enable the wireless nodes in a wireless mesh network communicate with each other and the gateways without the need of multi hopping and routing which requires master gateways in the network with high transmission power in order to transmit the master carrier signal for covering the network. The wireless nodes in the network will synchronize with the master gateways and will send their message which will be added to the master carrier signal and carried on to the other nodes in the network or the other master gateway.

15

Background of the invention

Wireless sensor network consists of sensor nodes and gateway. Sensor nodes will discover the available gateway and send the data to the gateway accordingly. The conventional wireless sensor network usually consists of one gateway. Therefore, all the sensor nodes will send their data to the gateway. This will cause the data traffic of sensor nodes which are nearby the gateway to be higher. This

25

will lead to higher message collision in the wireless sensor network. As a result, higher retransmissions are required and cause higher power consumption.

5 One of the methods to pass the message in a wireless sensor network is by multi hopping. When a gateway wants to send a request to a sensor node, the message will route through all the sensor nodes in the wireless sensor network by passing on the message from one sensor node to another until the
10 message reaches the desired destination. If the destination node is far away from the gateway, it will involve a lot of sensor nodes.

Sensor nodes will send messages with each other in a mesh
15 networks. More messages will lead to more traffic in the system. This will cause more power consumptions. As a result, the life time of the sensor nodes will be reduced.

One of the disadvantages by having one gateway in high
20 traffic sensor networks such as mesh networks or 6LoWPAN is the sensor nodes which are closer to the gateway would be consuming more power to relay the message so those nodes will die faster compare to the sensor nodes further from the gateway. Besides that, the sensor nodes which are nearer to
25 the gateway will be having very high traffic and will lead

to message collisions. The sensor nodes will not able to function if the gateway dies.

One of the disadvantages of having multi hopping in sensor networks such as mesh networks or 6LoWPAN is the need of a routing protocol which will increase the memory usage on the sensor nodes. Besides that, routing protocol will increase the complexity and computation overhead for the sensor nodes.

Therefore the present invention provides a system comprising at least one master gateway and one wireless node for wireless communication by sending and receiving a master carrier signal in a wireless network.

The master gateway will transmit the master carrier signal, periodic beacon and location information, and receive the combined data signal with said master carrier signal from a wireless node in the network.

The wireless node will transmit the data signal at the correct time and phase to combine with said master carrier signal and direct it to the desired destination.

The objective of the present invention is reduce the message overhead by eliminating the routing messages and multi hopping in the network.

5 Still another objective of the present invention is to reduce the computation overhead by eliminating the need for calculating the routes and processing the routing messages.

Still another objective of the present invention is to
10 reduce the memory overhead by eliminating the need for routing tables and buffering the messages from the neighbor nodes.

Still another objective of the present invention is to
15 reduce the power consumptions since the message, computation and memory overhead has been reduced.

Still another objective of the present invention is to enable the nodes to communicate with any other node or
20 master gateway in the network with low power transmission.

Still another objective of the present invention is to reduce the message delivery delay in the network by eliminating the need for multi hop communications.

25

These and other objects and advantages of the present invention will become apparent to those skilled in the art from a consideration of the following specification and claims.

5

Summary of the Invention

The wireless nodes can communicate with other nodes and gateways in a wireless mesh network without the need of multi hopping and routing. A master gateway with high transmission power is required in order to transmit the master carrier signal to cover the wireless network. The wireless nodes in the network will calculate the correct time and phase by using the location information of the desired destination. The wireless nodes will send their message at the right time and phase so that the message will be combined with the master carrier signal and sent to the desired destination at the correct angle.

Brief Description of the Drawings

Other objects, features, and advantages of the invention will be apparent from the following description when read with reference to the accompanying drawings. In the

drawings, wherein like reference numerals denote corresponding parts throughout the several views:

Figure 1 shows wireless communication using master carrier
5 signal.

Figure 2 shows wireless mesh sensor network.

Figure 3 shows the node (14) signal is directed to master
10 gateway (10) by determining the distance, d (51) and angle
(50).

Figure 4 shows the general process flow for wireless
communication with master carrier signal.

15

Figure 5 shows the detailed process flow for wireless
communication with master carrier signal with regards of
gateways.

20 Figure 6 shows the detailed process flow for wireless
communication with master carrier signal with regards of
wireless node.

Figure 7 shows wireless mesh network using master carrier
25 signal for communication.

Figure 8 shows wireless node sending message to another destined node.

Detailed Description of the Preferred Embodiments

5

In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be understood by those of ordinary skill in the art that the invention may be practiced without these specific details. In other instances, well-known methods, procedures and/or components have not been described in detail so as not to obscure the invention. Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

10

15

This invention consists of a system for wireless communication by sending and receiving a master carrier signal in a wireless network. The system consists of at least one master gateway and one wireless node.

20

The master gateway will transmit the master carrier signal (20), periodic beacon and location information, and receive

the combined data signal (22) with said master carrier signal (20) from a wireless node (14) in the network.

The wireless node will transmit the data signal (21) at the correct time and phase to combine (22) with said master carrier signal (20) and direct it to the desired destination.

The master gateway may or may not be connected to the backhaul. However, the master gateway should have high transmission power in order to cover the entire network and send beacon signal periodically. Since the master gateways (10) do not have any power supply limitations, they can do high power transmissions in the network. The master gateway will be using any of the existing methods to discover its location. If there is more than one master gateway in the network, they will perform time synchronization between each other. The master gateways will periodically send beacon signals which will be used by the sensors to calculate the correct time and phase to send their signals.

The system will include the time and phase calculation module. This will enable the wireless node in the network to calculate the correct time and phase by using the location information of the desired destination. The wireless nodes

will send their data signal at the right time and phase so that the data signal will be combined with the master carrier signal and sent to the desired destination at the correct angle. Therefore there will be no need for routing
 5 protocol in the network and then nodes can communicate with each other or with the master gateway without multi-hopping and routing.

The signal (21) from the node will be combined with the
 10 master carrier signal (20) from the master gateway to direct the signal (22) from the node to the master gateway or other destination nodes. In an array concept the signal (22) is combined in the following fashion:

$$S_r = I_0 + I_1 e^{j\beta d \cos\theta + \alpha}$$

15

Where I_0 is the signal (20) from the master gateway (13) and I_1 is the signal (21) from the node (14). β is the wave number, i.e. $2\pi/\lambda$ where λ is the wavelength of the carrier frequency and d is the separation between the node
 20 (14) and Master gateway (13) antennas. θ is the polar angle and α is the phase shift induced to control the direction.

The direction of the beam is the angle at which the cosine of the phase term given in the previous equation is maximized, ie.

$$5 \quad \text{Max}\{\cos(\beta d \cos\theta + \alpha)\}$$

One of the methods to determine the distance, d (51) and the location of the Master Gateway is by using GPS coordinates of the Master Gateway (13) and node (14). The required phase
10 term α , can then be introduced by the sensor to ensure that the signal is directed to the Master Gateway (10) at angle ϕ (50). Please refer to Figure 3 for details.

One of the advantages of this invention is to reduce the
15 message overhead by eliminating the routing messages and multi hopping in the network. Besides that, the invention will reduce the computation overhead by eliminating the need for calculating the routes and processing the routing messages. Furthermore, the invention will reduce the memory
20 overhead by eliminating the need for routing tables and buffering the messages from the neighbor nodes. The invention will be able to reduce the power consumptions since the message, computation and memory overhead has been reduced. The invention will enable the nodes to communicate
25 with any other node or master gateway in the network with

low power transmission and no need of routing and multi hopping.

The general flowchart of this invention is shown in Figure 4. The gateway will carry out time synchronization with other gateway and the nodes. Then, the gateway will send beacon signal periodically (30). The node will calculate the correct time to send the signal (21) after receiving the beacon signal from the gateway (31). The signal (21) from the node will combine (22) with the master carrier signal (20) and will be directed to the desired destination.

The detailed process flowchart for the gateways of this invention is shown in Figure 5. The gateway will send time synchronization message to the other gateway and the nodes. Then the gateway will discover and advertise its location and the location data of the nodes in the network. The master gateway (10) starts to transmit master carrier signal (20) periodically in synchronous with other gateway (33). The master gateway (10) will send beacon signal every T milliseconds (34). If the master gateway (10) is sending a message, it will set the sending time based on the active time of the nodes (14) and send the signal (36). If not, the master gateway (10) will just receive the incoming signals.

The detailed process flowchart for the wireless node of this invention is shown in Figure 6. The wireless node will synchronize its time with the gateway and will discover its location in the network and send the location data to the gateways. If the node is sending a message, the node will wait for receiving the beacon signal (37) and will calculate the right time and right phase to send the signal (38). The node will send the signal (21) at the correct phase (39). The signal (21) will combine (22) with the master carrier signal (20) and directed to the destination at the correct angle (40). If the node is not sending a message, it will receive the incoming signals during the active time.

As will be readily apparent to those skilled in the art, the present invention may easily be produced in other specific forms without departing from its essential characteristics. The present embodiments is, therefore, to be considered as merely illustrative and not restrictive, the scope of the invention being indicated by the claims rather than the foregoing description, and all changes which come within therefore intended to be embraced therein.

Claims

1. A system for wireless communication by sending and receiving a master carrier signal in a wireless network,

5 comprising :

at least one master gateway to transmit the master carrier signal (20), periodic beacon or location information, and to receive the combined data signal (22) with said master carrier signal (20) from a wireless nodes (14) in the

10 network; and

at least one wireless node to transmit the data signal (21) at the correct time and phase to combine (22) with said master carrier signal (20) and direct it to the desired destination.

15

2. The system for wireless communication by sending and receiving a master carrier signal in a wireless network as claimed in claim 1, wherein said master gateway may or may not be connected to the backhaul.

20

3. The system for wireless communication by sending and receiving a master carrier signal in a wireless network as claimed in claim 1, wherein the master gateway should have high transmission power in order to cover all the network and send beacon signal periodically.

25

4. The system for wireless communication by sending and receiving a master carrier signal in a wireless network as claimed in claim 1, wherein the master gateway will be using any of the existing methods to discover its location.

5

5. The system for wireless communication by sending and receiving a master carrier signal in a wireless network as claimed in claim 1, wherein the wireless node includes time and phase calculation module.

10

6. A method for wireless communication by sending and receiving a master carrier signal in a wireless network, said method comprising the steps of:

transmitting the master carrier signal (20), periodic beacon

15 and location information by the master gateway (13);

receiving the combined data signal (22) with the master carrier signal (20) from the wireless nodes (14) in the network by the master gateway (13); and

transmitting the data signal (21) by the wireless node (14)

20 at the correct time and phase to combine (22) with the master carrier signal (20) and direct it to the desired destination.

7. The method for wireless communication by sending and

25 receiving a master carrier signal in a wireless network as

claimed in claim 6, wherein said step of transmitting the master carrier signal, periodic beacon and location information by the master gateway includes the step of sending a time synchronization message to any other master gateway if there is more than one master gateway in the network.

8. The method for wireless communication by sending and receiving a master carrier signal in a wireless network as claimed in claim 6, wherein said step of transmitting the master carrier signal, periodic beacon and location information by the master gateway includes the step of sending time synchronization and master gateway location message to the nodes in the network.

15

9. The method for wireless communication by sending and receiving a master carrier signal in a wireless network as claimed in claim 6, wherein said step of transmitting the master carrier signal, periodic beacon and location information by the master gateway includes the step of transmitting the master carrier signal periodically in synchronous with the other master gateway if there is more than one master gateway in the network.

10. The method for wireless communication by sending and receiving a master carrier signal in a wireless network as claimed in claim 6, wherein said step of transmitting the master carrier signal, periodic beacon and location
5 information by the master gateway includes the step of sending a beacon signal periodically to the network for time and phase calculation for the wireless nodes in the network.

11. The method for wireless communication by sending and
10 receiving a master carrier signal in a wireless network as claimed in claim 9, wherein said step of sending a message from a wireless node (14) to the desired destination includes the step of receiving the beacon signal which is sent by the master gateway (13).

15
12. The method for wireless communication by sending and receiving a master carrier signal in a wireless network as claimed in claim 9, wherein said step of sending a message from a wireless node to the desired destination includes the
20 step of calculating the right time and phase to send the message by using the distance value (51) and angle (50) from the desired destination and calculating the phase term.

13. The method for wireless communication by sending and
25 receiving a master carrier signal in a wireless network as

claimed in claim 9, wherein said step of sending a message from a wireless node to the desired destination includes the step of sending the message at the right time and phase to combine with the master carrier signal and be directed to
5 the desired destination and the correct angle (50).

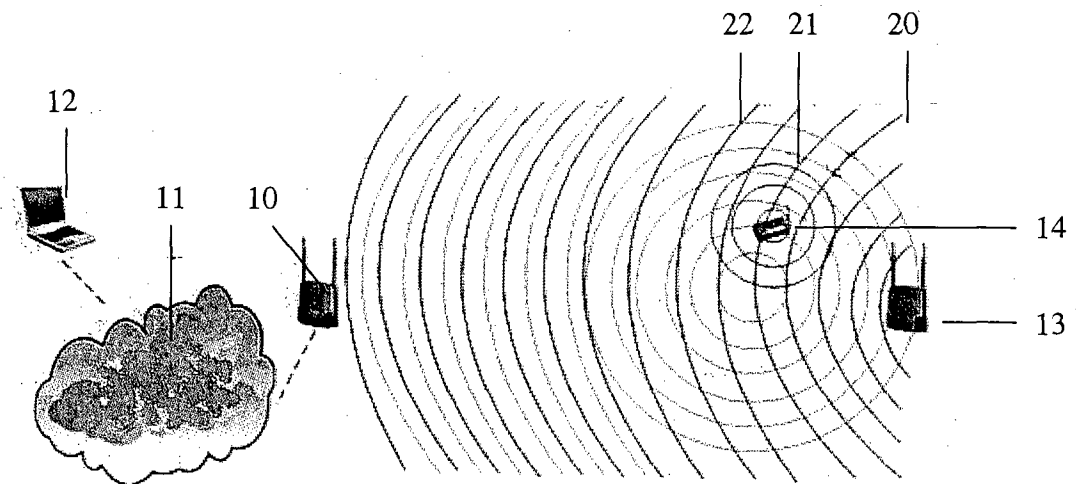


Figure 1

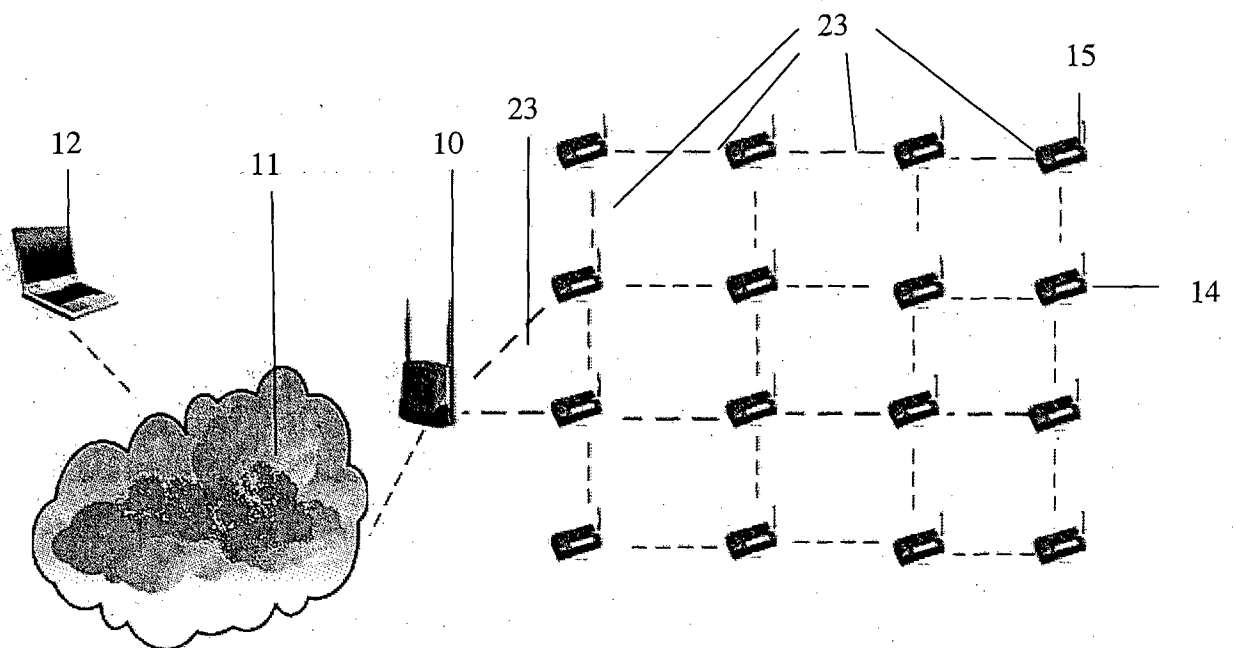


Figure 2

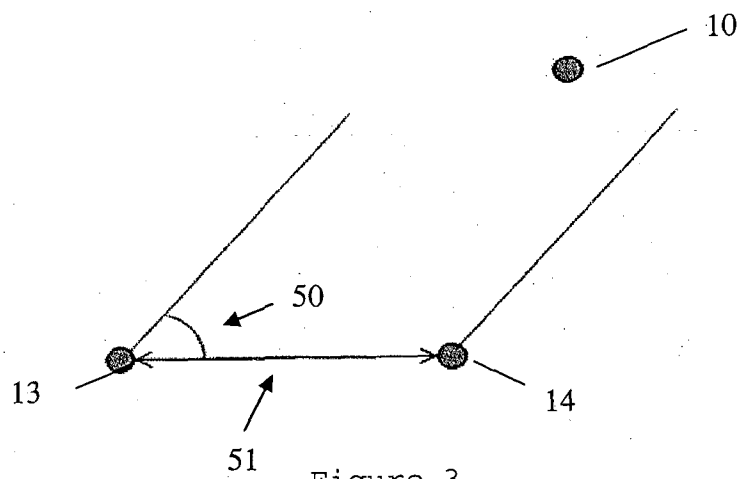


Figure 3

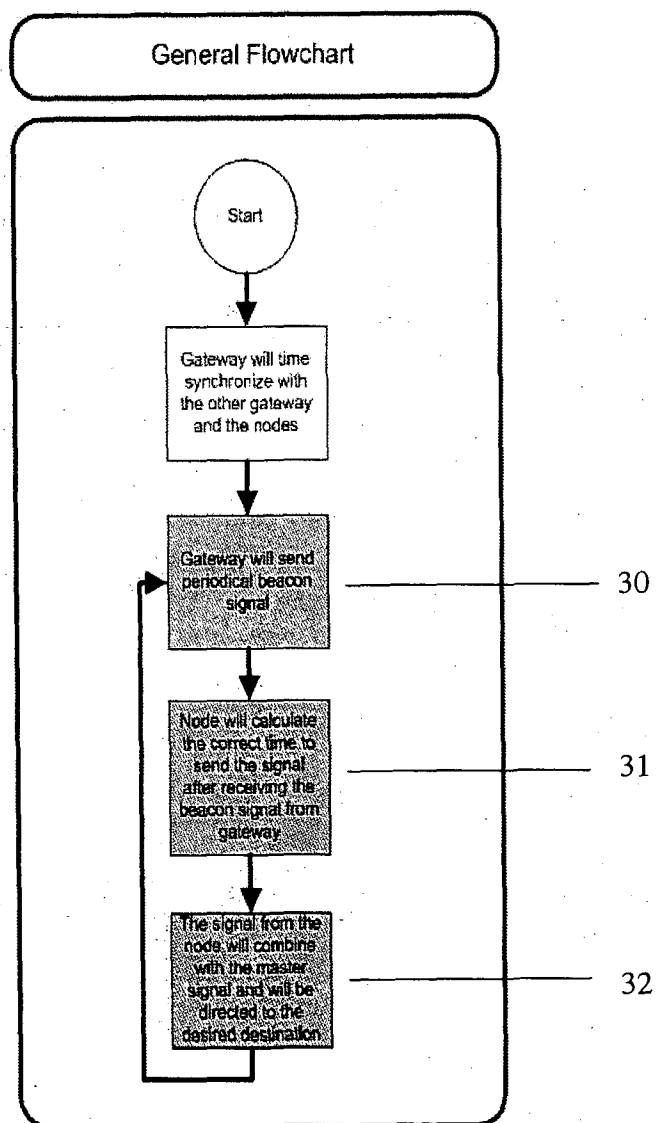


Figure 4

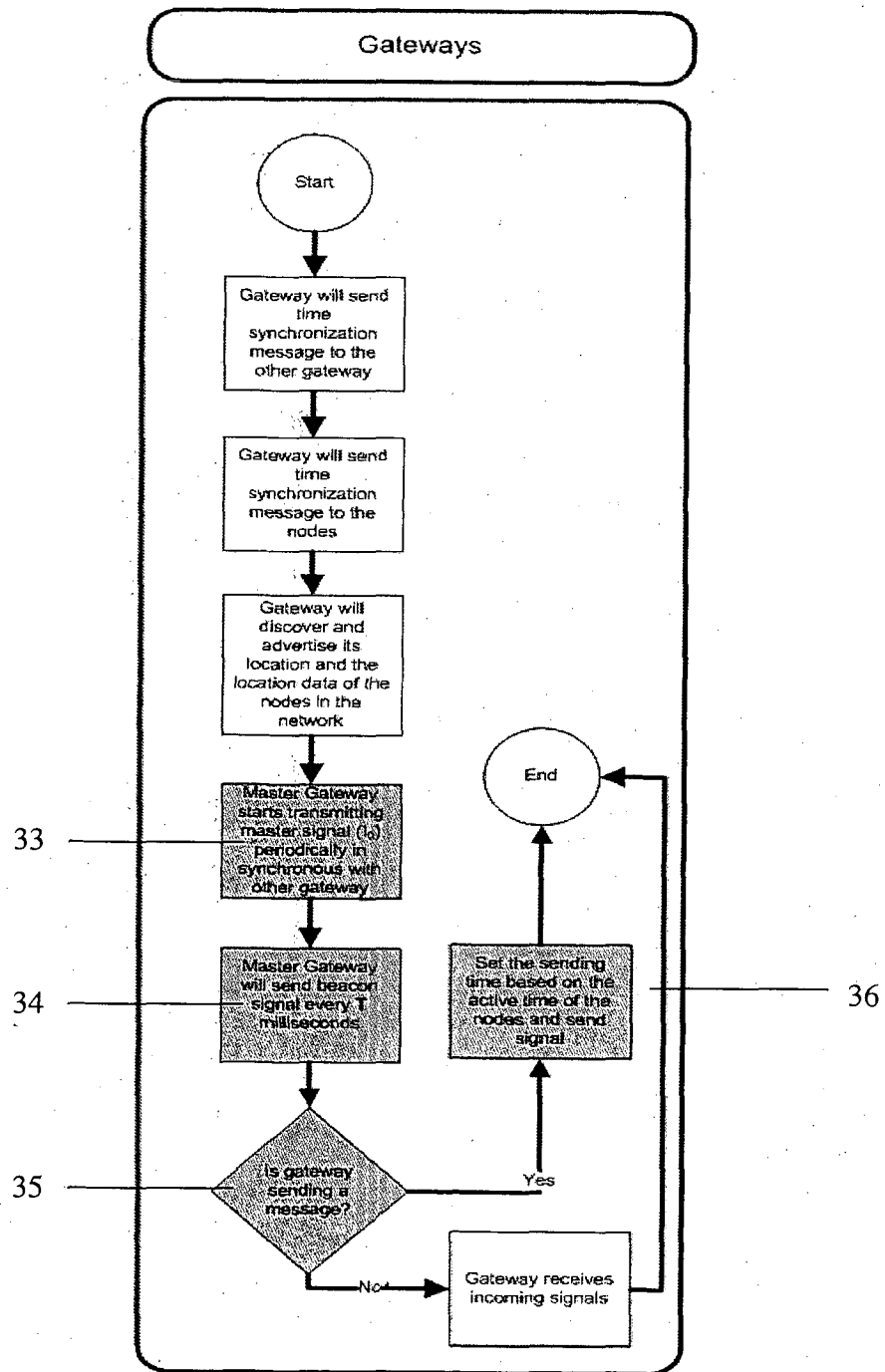


Figure 5

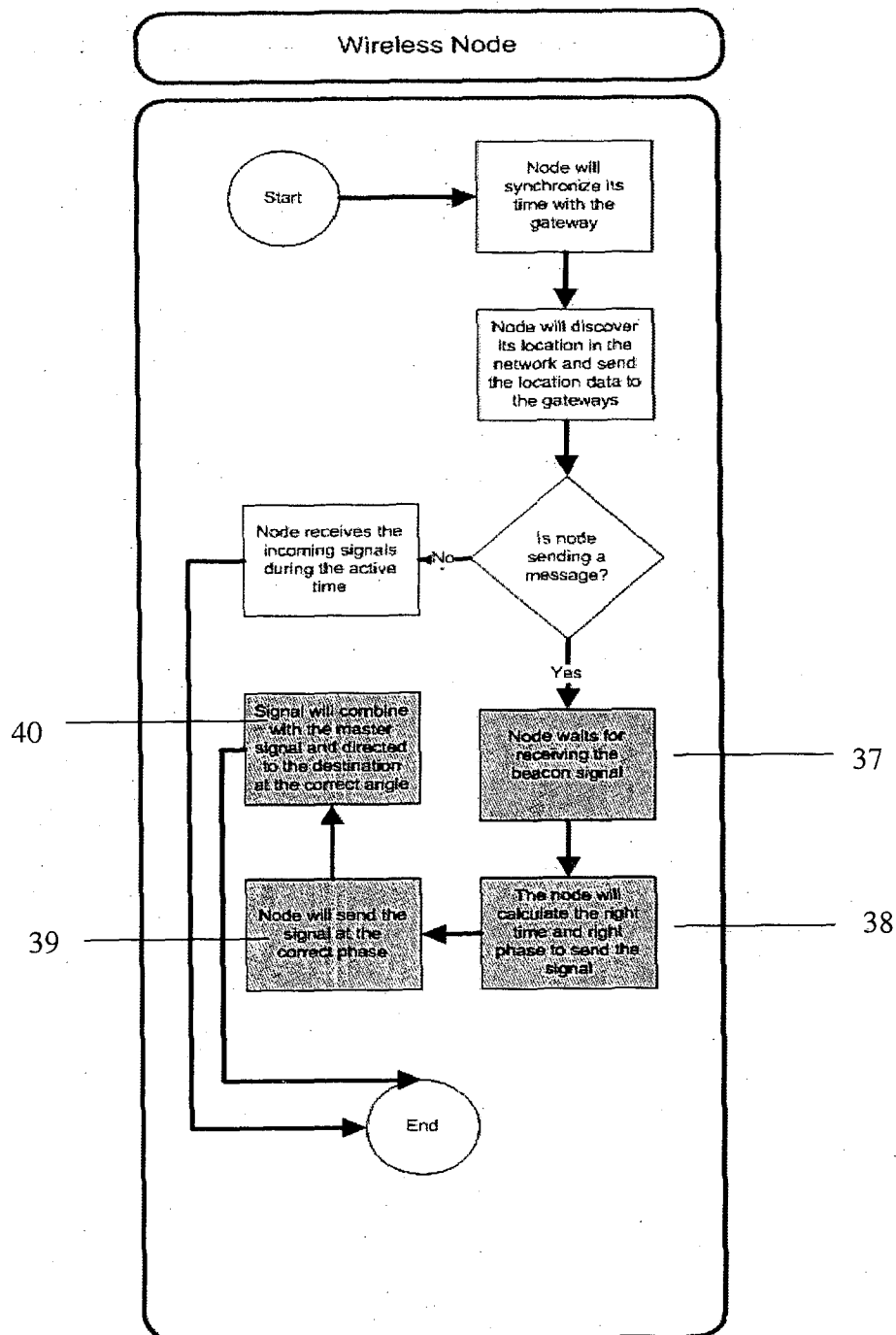


Figure 6

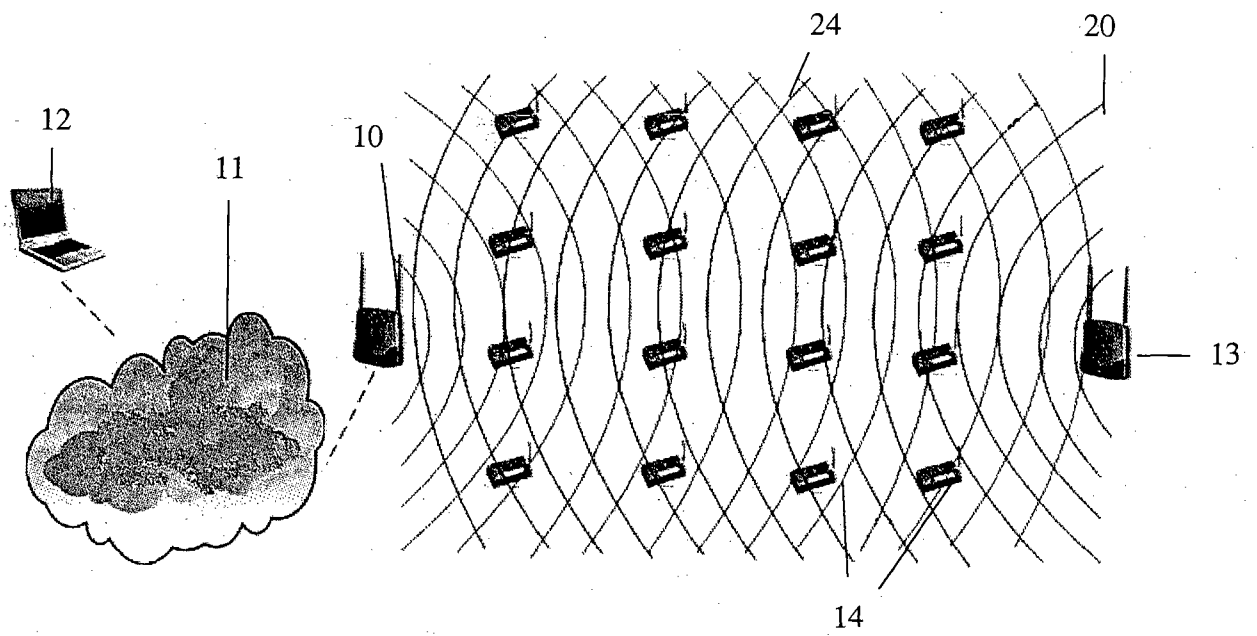


Figure 7

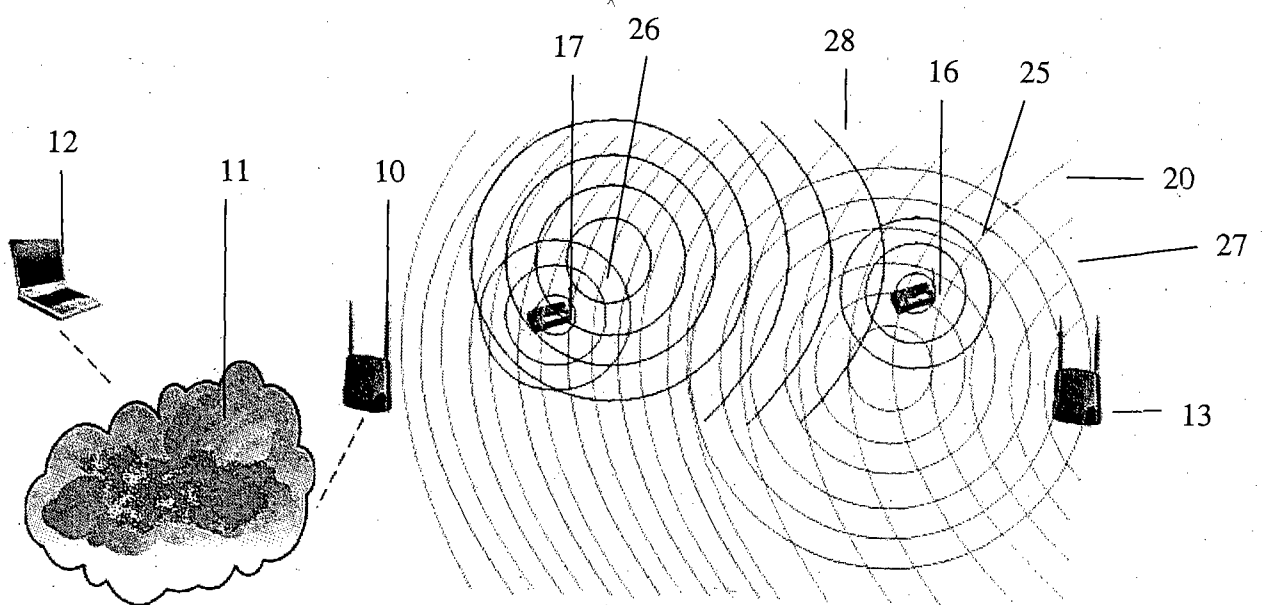


Figure 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/MY2013/000102

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W88/04 H04W40/20
ADD.

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)
H04W H04B

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 practicable, search terms used)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 7 653 394 B2 (MCMILLIN BRIAN K [US]) 26 January 2010 (2010-01-26) figure 1 column 17, line 8 - line 25 column 18, line 52 - line 58 column 19, line 33 - line 40 column 21, line 1 - line 22 column 51, line 13 - line 20 column 51, line 31 column 52, line 5 - line 6 column 66, line 59 column 67, line 1 - line 3 -----	1-6
A	US 2007/223438 A1 (BENNETT JAMES D [US]) 27 September 2007 (2007-09-27) figure 1 paragraph [0037] -----	1-13



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

12 November 2013

Date of mailing of the international search report

19/11/2013

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Akhertouz Moreno, Y

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/MY2013/000102

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 7653394	B2	26-01-2010	
		AU 5158800 A	18-12-2000
		AU 5161900 A	18-12-2000
		CA 2374845 A1	07-12-2000
		CN 1555637 A	15-12-2004
		EP 1232614 A2	21-08-2002
		JP 2003508939 A	04-03-2003
		US 2005226201 A1	13-10-2005
		WO 0074306 A2	07-12-2000
		WO 0074402 A1	07-12-2000

US 2007223438	A1	27-09-2007	
		CN 101217784 A	09-07-2008
		CN 101242648 A	13-08-2008
		CN 101242649 A	13-08-2008
		EP 1942693 A2	09-07-2008
		KR 20080064754 A	09-07-2008
		TW 200845783 A	16-11-2008
		US 2007223438 A1	27-09-2007
