



(51) **International Patent Classification:**
H04W 8/18 (2009.01) H04W 80/00 (2009.01)
H04W 40/04 (2009.01)

(21) **International Application Number:**
PCT/MY2010/000160

(22) **International Filing Date:**
2 September 2010 (02.09.2010)

(25) **Filing Language:** English

(26) **Publication Language:** English

(30) **Priority Data:**
PI20093646 2 September 2009 (02.09.2009) MY

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

(72) **Inventors; and**

(75) **Inventors/Applicants (for US only):** TING, Kee Ngoh [MY/MY]; Mimos Berhad, Technology Park Malaysia, Bukit Jalil, 57000 Kuala Lumpur (MY). AHMAD, Tariq Abdullah [MY/MY]; Mimos Berhad, Technology Park Malaysia, Bukit Jalil, 57000 Kuala Lumpur (MY). SAA-DAT, Md Nazmus [MY/MY]; Mimos Berhad, Technology Park Malaysia, Bukit Jalil, 57000 Kuala Lumpur (MY).

(74) **Agent:** MOHAN, K.; Adastra Intellectual Property Sdn Bhd, A-28-10, Menara UOA Bangsar, No. 5, Jalan Bangsar Utama 1, 59000 Kuala Lumpur (MY).

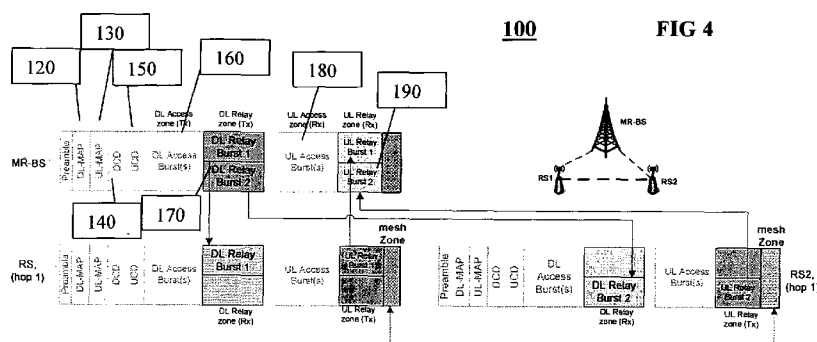
(81) **Designated States (unless otherwise indicated, for every kind of national protection available):** AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States (unless otherwise indicated, for every kind of regional protection available):** ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) **Title:** METHOD AND SYSTEM FOR USE IN MULTI HOP WIRELESS MESH NETWORK



(57) **Abstract:** The present invention discloses a method and system for use in a wireless network, whereby the present invention enables mesh communication within said network. Mesh communication between relay stations located adjacent to each other is established, either through point to multipoint or point to point transmission. The system comprises a mesh zone (100) for enabling such mesh communication which is created by a base station upon prompted within a network.



METHOD AND SYSTEM FOR USE IN MULTI HOP WIRELESS MESH NETWORK**FIELD OF INVENTION**

5 The preferred embodiments of the present invention directs to a method and system for use in a wireless mesh network, and more particularly a method and system for use in a multi hop wireless mesh network.

BACKGROUND

10

The need to improve network capacity has been progressively emerging and thus placed as a significant target among researchers of the relevant art when developing advanced communication paradigm. The main challenges are to provide resilient, cost efficient and reliable connections for future generation networks.

15

One of the most prominent and reliable communication paradigms of this age is the wireless mesh network (WMN), whereby in general, this particular paradigm is developed to enable wireless interconnections between nodes, by means of remote information transmission. Nowadays, wireless networking is commonly associated with multi-hop networking and
20 mesh networking, in which for such network, information is conveyed or routed from a source to a destination using two or more networks.

IEEE 802.16j is a wireless multi-hop network communication standard extended from IEEE 802.16e predominantly to improve network capacity and extend network coverage size by
25 way of forming tree or network topologies using multi-hop relays approach. Nevertheless,

tree topology although simple and non-complex, it is known to be less flexible than the mesh network approach in view of data routing. This is owing to the fact that with tree topology restricts the flow of data to the dedicated path which therefore limits data routing, unless the tree structure is changed. Additionally, relay stations are known to be static or fixed within a position, therefore the tree structure is rarely changed, dynamic or flexible data routing may not be feasible compared to that of the mesh network. **FIG 1** illustrates this limitation in the conventional wireless multi-hop networks. It can be concluded that tree topology multi-hop wireless networks current structure enables transmission over limited relay links, particularly among super-ordinate and sub-ordinate stations inclusive of relay stations (RS) and multi-hop relay base stations (MR-BS). As a consequence, peer to peer transmission among relay stations in said tree topology and transmission between nodes from different tree topology are not possible as suitably shown in **FIG 1**.

In order to accommodate the limitation as described above, more radio resources are used to provide broadcasting/multicasting as well as local traffic transmission. This current ultimatum is shown in **FIG 2(a)-(c)**. In this example, there is shown the broadcast/multicast traffic supported by both tree and mesh topology respectively. It can be seen that several relay stations are not linked despite being located adjacent to each other. Such linking may be possible in the event that meshing between the respective relay stations are provided or available. It is also apparent from the diagram that the amount of transmission can be reduced with mesh topology.

In order to prevail over the shortcomings of the conventional methods and systems as discussed above, experts of the respective industry are constantly developing solutions to improve the network capacity for multi-hop networking.

An exemplary of a related prior art as one of the available solutions to improve network capacity is as disclosed in European Patent Application EP 1962542 – *An Apparatus and Method for Transmitting and Receiving Control Information in Multi-hop Relay Broadband Wireless Communication System*. The invention relates to a frame structure for relay, whereby in this invention the frame structure is divided into a plurality or multiple zones. Accordingly, there is provided a predefined operational function for each zone so as to reduce control signaling. Nonetheless, this prior art does not disclose any information in relation to supporting relay stations on a similar scale, thereby the disclosed invention may not be expedient for mesh networking.

In another prior art as disclosed in WO 2008/049843 – *Frame Structure for a Multi-hop Wireless System*, the frame structure is provided with additional areas with predefined functions. These areas aid to provide connections between super-ordinate station to relay stations (RS) and from relay station (RS) to subordinate station. The structure however is molded based on the signaling process between MR-BS to RSs.

As discussed above, much effort has been directed toward improving the capability of wireless networks, in attempt to increase the network expandability. Nonetheless, great majorities of the known in the art systems have their own drawbacks, be it in the method of operation or are prohibitively expensive.

Recognizing the aforementioned shortcomings, the present invention has been accomplished to significantly improve the conventional methods and systems. Accordingly, it is a primary object of the method and system of the present invention to provide mesh communication and data transfer between relay stations (RSs) which are within the communication range or

adjacent to each other by means of point to multipoint (PMP) or point to point (PTP) transmission.

It is therefore another object of the present invention to provide a method and system for use in multi-hop mesh wireless network, said method and system provides expediency in connecting between nodes via mesh transmission within a tree network topology.

It is further object of the present invention to provide a method and system for use in multi-hop mesh network, said method and system is highly reliable and economical.

SUMMARY OF INVENTION

In one aspect, there is disclosed a method for use in a wireless network comprising the steps of: requesting for a mesh communication (S300) ; creating a mesh zone within the network (S301); establishing connection between two communication nodes and assigning at least one mesh identification means (S302); scheduling mesh traffics and notifying the destination nodes (S303); establishing mesh communication (S304); detecting any scheduled mesh communication (S305); and terminating mesh communication upon requested (S306).

In another aspect of the present invention, there is provided a frame structure for supporting a wireless network, said frame structure comprising a mesh zone (100), said mesh zone (100) for providing mesh communication within said wireless network.

In a further aspect of the present invention, there is provided a system for use in a wireless network, said system comprising a plurality of communication nodes and a frame structure

for supporting said wireless network, characterized in that the frame structure comprising a mesh zone (100) for enabling transferring and receiving data between said nodes by way of mesh communication.

5 BRIEF DESCRIPTION OF THE FIGURES

The invention will be more understood by reference to the description below taken in conjunction with the accompanying drawings herein:

10 **FIG 1** illustrates a prior art in relation to wireless multi-hop network;

FIG 2(a)-(c) illustrate the examples of the existing multicast/broadcast carried by tree and mesh topology;

15 **FIG 3** illustrates the existing frame structure for IEEE 802.16j;

FIG 4 illustrates the frame structure in accordance with a preferred embodiment of the present invention;

20 **FIG 5 to FIG 6** illustrate the examples of traffic directions and types, the sending and receiving data in mesh zone in accordance with another preferred embodiment of the present invention; and

FIG 7 shows the operational flowchart of the system and method in accordance with a
25 preferred embodiment of the present invention.

DETAILED DESCRIPTION

In addition to the drawings, further understanding of the object, construction, characteristics and functions of the invention, a detailed description with reference to the embodiments is
5 given in the following.

FIG 3 illustrates a simplified frame structure of IEEE 802.16j, whereby the access zones and relay zones are defined either within the uplink (UL) sub-frame or downlink (DL) sub-frame. The conventional structure further comprises the frame structure for multi-hop relay base
10 station (MR-BS), relay station 1 (RS1) and relay station 2 (RS2).

It is generally known that there are two primary approaches for supporting relaying of time division transmit and receive relay stations (TTR- RSs). In the first approach, one or more relay stations (RSs) or multi-hop relay base stations (MR-BS) frames are allowed to be
15 grouped into a multi-frame with repeating pattern of allocated relay zones. Suitably, the MR-BS and RSs are assigned to transmit, receive or be idle in each of the predefined relay zones within the multi-frame. The second approach enables a single frame structure consisting of more than one relay zone. The RS and MR-BS are allowed to transmit, receive and be idle within said relay zone.

20 Both first and second approaches specify only one zone in DL and UL sub-frame, for a super-ordinate RS to all its subordinates RSs, as can be seen in **FIG 3**. It is further noted that the transceiver state in both approaches for the common zone for RSs are attached to similar super-ordinate RS are identical. For instance, referring still to **FIG 3**, transceiver of DL relay

zone of RS1 and RS2 are in receiving state. Similarly, both UL relay zone of RS1 and RS2 are in transmitting state.

It is apparent that direct communication between two RSs attached to the same super-ordinate station is not feasible based on the frame structure discussed in the preceding paragraphs. This is also the case for transmission between two nodes from different family tree. It would be highly advantageous if such communication is enabled as this would lead to providing a more reliable continuous connection.

The present invention solves the aforementioned predicament by way of providing a new frame structure with an additional zone, said zone referred herein as the mesh zone (100).

The mesh zone (100) creates or provides an independent time and frequency domain within the existing frame structure which enables either PMP or PTP communications between any two or a plurality of relay stations within the vicinity of each other regardless of the family tree and between other hops from MR-BS. The present invention realizes the idea of allowing direct communication within mesh communication even if such direct communication between nodes not supported by the standard or not supported by the conventional multi-hop wireless communication system.

FIG 4 illustrates the frame structure with the additional mesh zone (100). The existing frame structure may comprise of conventional components, including a preamble (110), DL-MAP (120), UL-MAP (130), DCD (140), UCD (150), DL Access Bursts (160), DL Relay Burst 2 (170), UL Access Bursts (180) and UL Relay Burst 2 (190). It is preferred that said frame structure (100) may contain a preamble at the beginning of the zone for synchronization

between relay stations. As can be seen in **FIG 4**, communication is enabled between relays by means of the mesh zone (100). Connection provided with the aid of mesh zone (100) is bidirectional whereby the mesh zone (100) can be used in either sending or receiving traffic based on the suitable zone configuration and traffic scheduling.

5

In accordance with a preferred embodiment of the present invention, the mesh zone (100) may be created by re-using multiple frame structure configurations through, but not limiting to RS_Config-CMD, in which the settings of the zones and their respective transceiver mode is provided in a frame and can be suitably decided. Detailed configuration for the mesh zone (100) based on another preferred embodiment of the present invention will be described herein.

10

With reference to **FIG 5** and **FIG 6** which illustrate the examples of traffic directions and types, the sending and receiving data in mesh zone (100) may be scheduled by MR-BS in centralized scheduling mode or local scheduling in RS in distributed scheduling.

15

Referring to another preferred embodiment of the present invention, upon specified the mesh zone (100) the MR-BS may stay idle at a predefined time domain which is the blue zone in **FIG 4**, so as to reduce interference or this zone may be reconfigured for use in UL access.

20

The first example as seen in **FIG 5** provides a frame structure for two hops occurrence whereby the broadcast/multicast traffic may be sent from RS1 to RS2, RS3 and RS4 simultaneously through the mesh zone (100). In this structure, the transceiver mode is preset such that the mesh zone (100) in RS1 is in transmitting mode whilst RS2, RS3 and RS4 are in receiving mode during frame configuration.

25

Another example of structure in accordance with a preferred embodiment of the present invention is as shown in **FIG 6**. This structure encompasses the unicast traffic traverse through mesh link from RS1 to RS2 and RS4 simultaneously using OFDMA.

- 5 In the event that centralized scheduling mode for the mesh operation is selected, the existing or conventional RS_Relay MAP message may be re-used. On the other hand, for distributed scheduling mode, coordination between RSs and MR-BS is required on time by time basis and the conventional RS-SCH message can be used for this purpose.
- 10 The messaging involved for the creation of mesh zone (100) in accordance with a preferred embodiment of the present invention will be described herein. It would be apparent to a person skilled in the art that these steps may vary and not limiting to those described, however to achieve the desired outcome within the scope of the appended claims.
- 15 Modifications are implemented on the s16j standard draft D9, section 11.25.9 whereby two (2) of the six (6) reserved bits will be used to indicate number of mesh zones (as underlined) in a frame in the event that the multiple frame structure configurations is performed by MR-BS, as shown in **TABLE 1** below:

20

TABLE 1***Modification to S16j Standard***

<i>Name</i>	<i>Type</i>	<i>Length</i>	<i>Value</i>	<i>Scope</i>
<i>DL subframe configuration</i>	28	<i>variable</i>	<i>Remain unchanged as in D8 document</i>	<i>RS_Config-CMD</i>
<i>UL subframe configuration</i>	29	<i>variable</i>	<i>Number of frame (8-bit unsigned)</i> <i>for(i = 0; i < Number of frame; i++){</i> <i>Number of zones (unsigned 2-bit)</i> <i>Reserved (4-bit unsigned)</i> <i><u>Number of mesh zone (2 bits)</u></i>	<i>RS_Config-CMD</i>

			<pre> for(j = 0; j < Number of zones; j++){ Transceiver mode (unsigned 2-bit) Zone mode (1 bit) OFDMA Symbol Offset (unsigned 7-bit) Frame Configuration Duration (unsigned 5-bit) Zone Configuration indicator (unsigned 1-bit) If(Zone Configuration indicator == 1) { Zone Configuration IE() (variable size in bytes) } } </pre>	
--	--	--	---	--

For this configuration the first zone refers to the access zones for DL sub-frame configuration. The transceiver mode in the relay zone is either one of the following modes: Tx mode (00), Rx mode (01), or idle mode.

5

In the event that the transceiver is in idle mode, it does not transmit or receive any signals or data.

As shown in **TABLE 1**, the number of mesh zone is indicated, whereby the mesh zone may be allocated behind access and relay zones. As for the zone mode, this section indicates that the zone as stated therein is assigned for use in access link (0) or for use as relay/mesh link (1). The OFDMA section as stated in **TABLE 1** indicates that the relay zone or mesh zone may start at the OFDMA symbol offset, counted after the preamble of the corresponding frame. The frame configuration duration indicates that the relay zone or mesh zones ends after the duration starting from the OFDMA symbol offset. The unit of duration is an OFDMA symbol.

10

15

FIG 7 shows the operational flowchart of the system and method in accordance with a preferred embodiment of the present invention.

Referring to **FIG 7**, in effect, the first step involved is starting the system for multi-hop
5 wireless communication system. It is preferred that the said system operates based on conventional 16j communication standard. A notification may be initiated in order to enquire as to whether the current system requires mesh communication (S 300). In the event that the current system requires mesh communication, the MR-BS is accordingly notified thus subsequently proceeds to create a mesh zone (S 301). In this process, a mesh connection is
10 created between two RSs and a mesh CID is assigned (S302). Upon assigned the mesh CID, mesh traffics are suitably scheduled (S303) and the source and destinations of the RSs are notified. The next stage is the initiation of mesh communication as requested (S304). Termination of mesh communication may be performed at any period. Prior to termination, the system may proceed to check any form of mesh communication scheduled (S305) on the
15 same mesh link. If there is existence of other mesh communication scheduled on the same mesh link, data transmission may be continued. Otherwise, mesh communication is terminated (S306).

The present invention is applicable for both in-band and out-band relay in which the access
20 zone is therefore assigned for use as relay zone or mesh zone and access link is handled by an independent radio interface which normally operates in different carrier frequency.

Additionally, the present invention is applicable for any form or number of hops which is supported by IEEE 802.16j standards or multi-hop wireless network.

It should be mentioned that the mesh zone (100) of the present invention may be created if desired, which means it is compatible with any form of the conventional multi-hop relay network upon created. In other words, the method and system of the present invention may be operated with a communication network operated based on 16j standard enables the conventional network to request for mesh communication and terminate said mesh communication at any point of time.

The present invention may be modified in light of the above teachings. It is therefore understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

CLAIMS

1. A method for use in a wireless network comprising the steps of:

requesting for a mesh communication (S300) ;

5 creating a mesh zone within the network (S301);

establishing connection between two communication nodes and assigning at least one mesh identification means (S302);

scheduling mesh traffics and notifying the destination nodes (S303);

establishing mesh communication (S304);

10 detecting any scheduled mesh communication (S305); and

terminating mesh communication upon requested (S306).

2. The method as claimed in Claim 1 wherein the two communication nodes are relay stations and base stations.

15

3. The method as claimed in Claim 1 wherein the connection identification means is the form of a CID.

4. The method as claimed in Claim 1 wherein the creation of mesh zone is performed by a

20 MR-BS.

5. The method as claimed in Claim 1 wherein the method is for use in multi-hop wireless mesh network.

6. The method as claimed in Claim 1 wherein the termination of mesh network may be performed at any point of time.

7. A system for use in a wireless network, said system comprising a plurality of communication nodes and a frame structure for supporting said wireless network, characterized in that the frame structure comprising a mesh zone (100) for enabling transferring and receiving data between said nodes by way of mesh communication.

8. The system as claimed in Claim 7, wherein the nodes are relay stations and base stations.

9. The system as claimed in Claim 8 wherein it is used for a multi-hop wireless network.

1/4

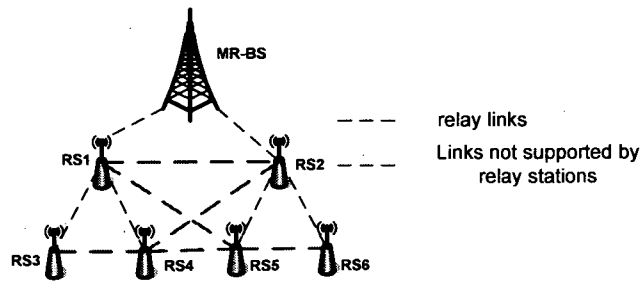


FIG 1

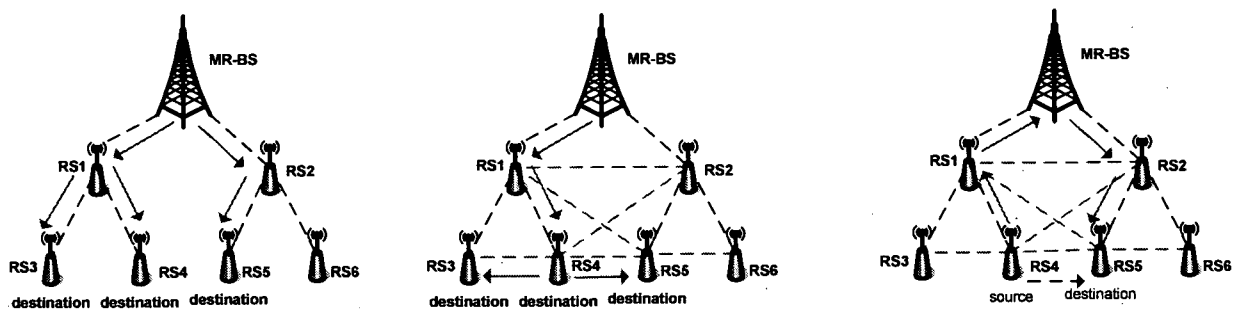


FIG 2

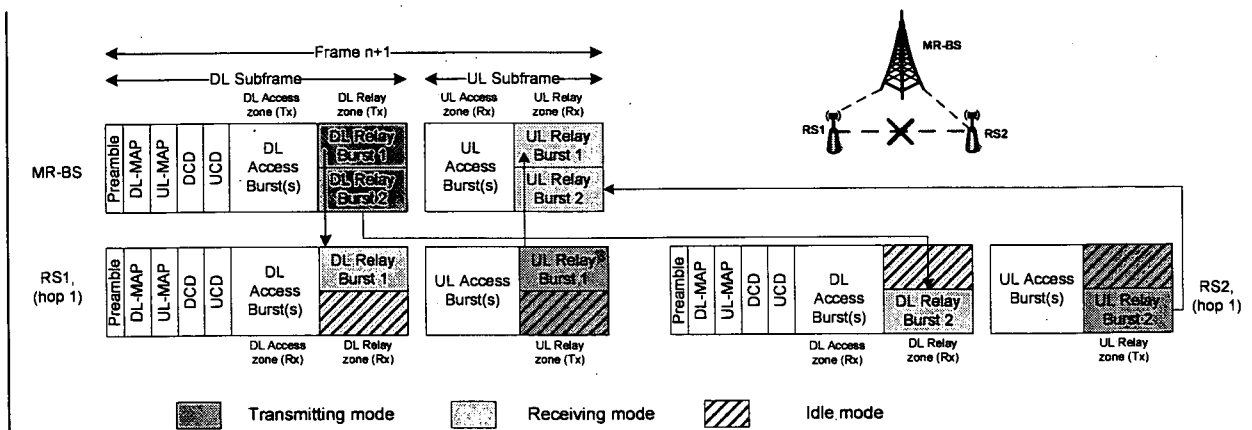


FIG 3

2/4

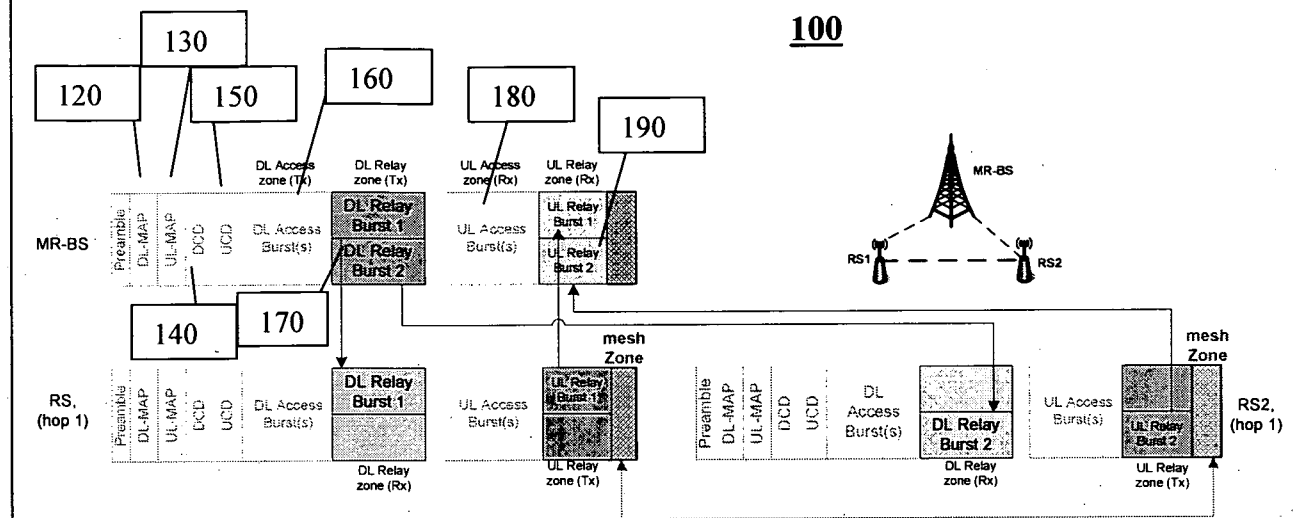


FIG 4

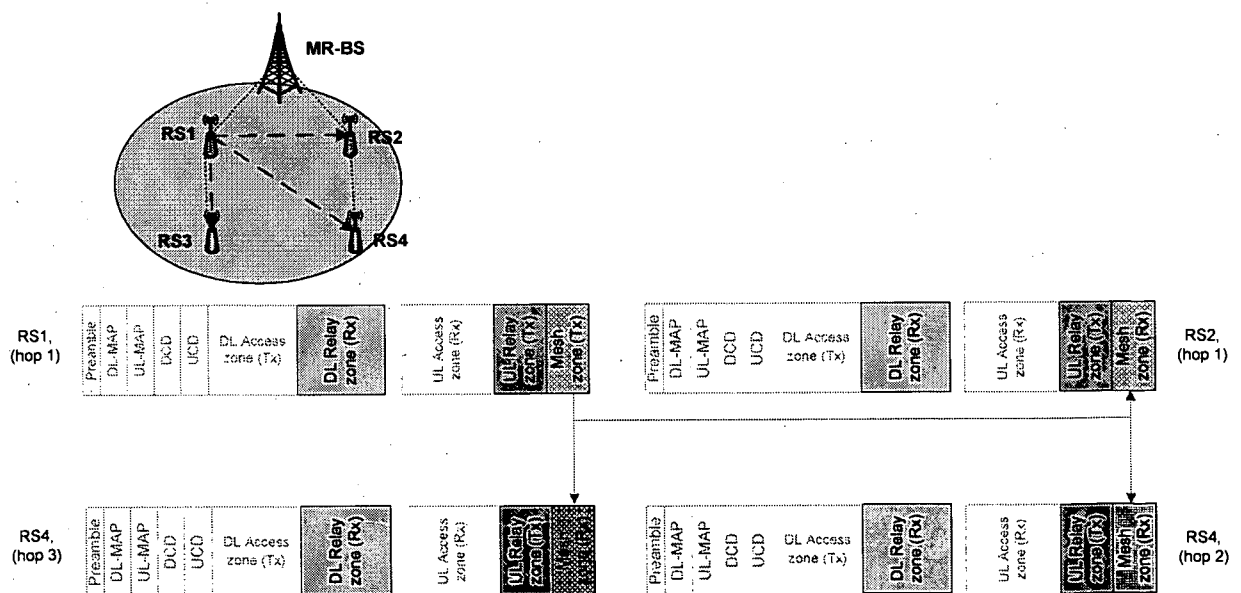


FIG 5

3/4

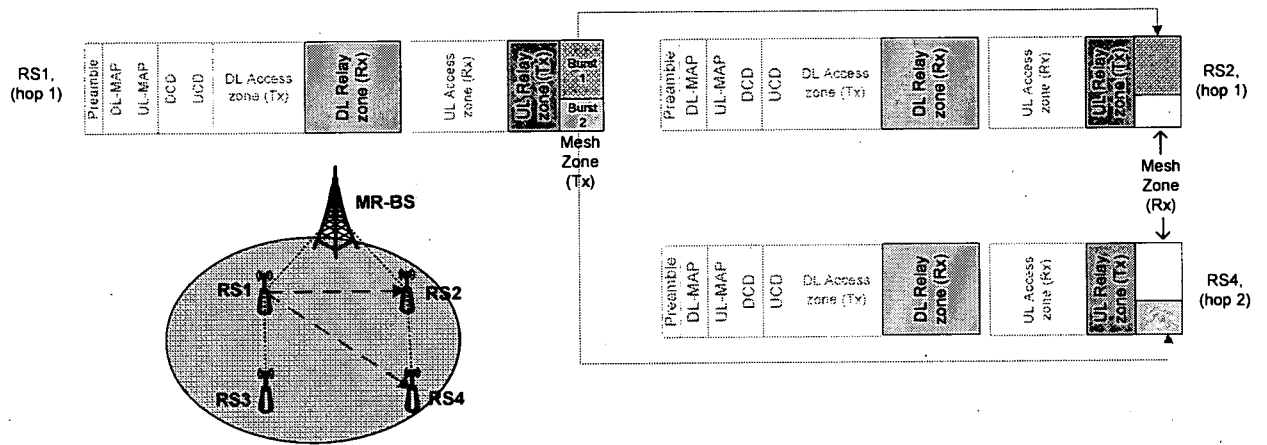


FIG 6

4/4

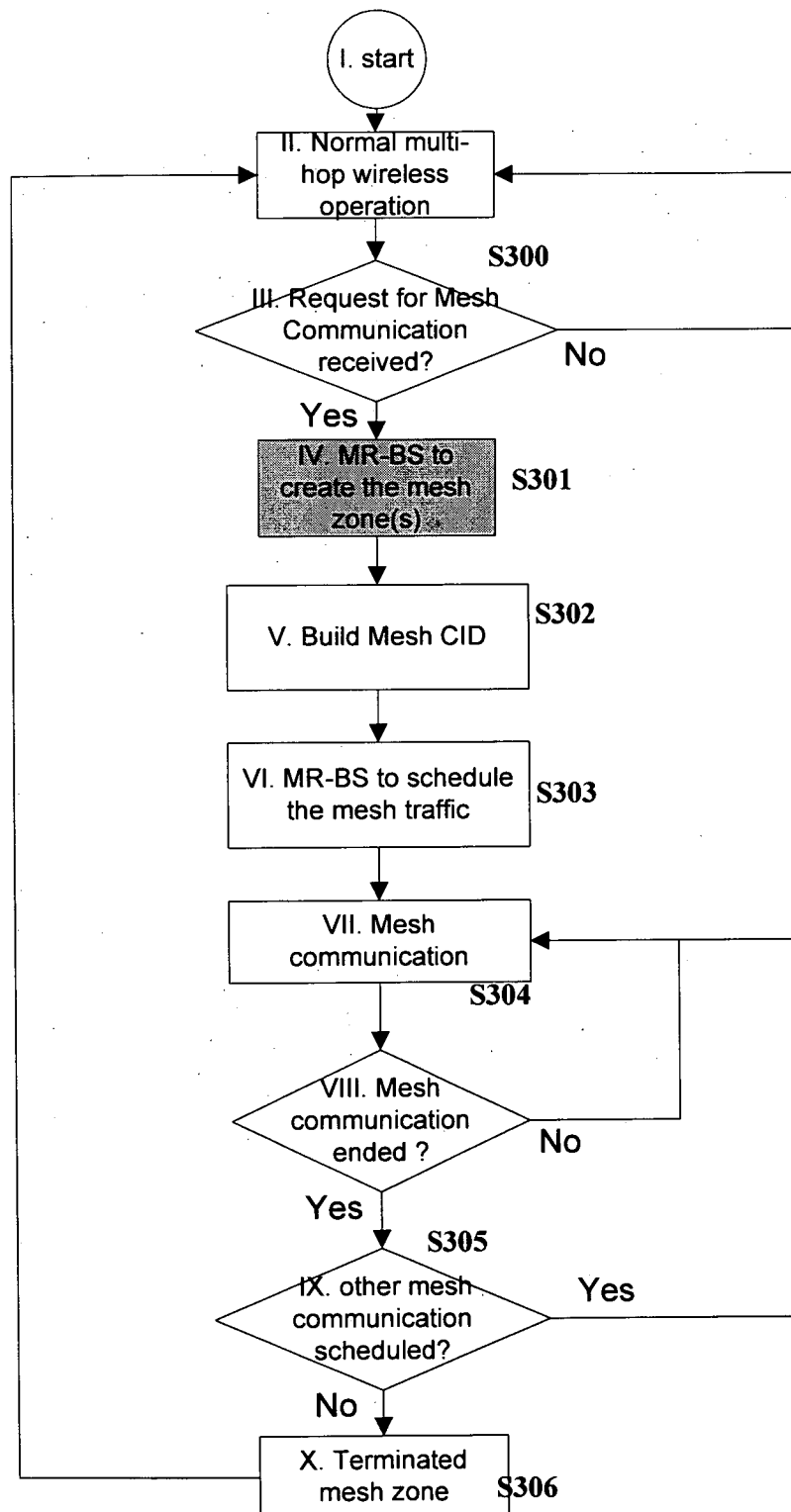


FIG 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2010/000160

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

H04W 84/18 (2009.01) **H04W 40/04** (2009.01) **H04W 80/00** (2009.01)

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)

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)

EPODOC, WPI with IPC marks and keywords including wireless, mesh, multi-hop, frame, dynamic, ad-hoc, establish. Google Scholar with similar keywords.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	Abu Ali, N. A. et al.: "IEEE 802.16 Mesh Schedulers: Issues and Design Challenges," IEEE Network Magazine, vol. 22, issue 1, p.58-65, 2008. - See whole document, in particular see p58-60, figure 1	1-2, 4-9 3
X	US 2009/0003298 A1 (CHU et al.) 1 January 2009 - See figures 4, 6, 7, paragraphs [0010]-[0012], [0044], [0048]-[0050], [0067]	7-9
X	Akyildiz, I. F. et al.: "A Survey on Wireless Mesh Networks," IEEE Communications Magazine, vol. 43, no. 9, s23-s30, Sept. 2005 - See pages S23-S24, figures 1 and 2	1, 2, 5

☒ 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	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"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
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
19 November 2010

Date of mailing of the international search report
25 NOV 2010

Name and mailing address of the ISA/AU
AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
E-mail address: pct@ipaustralia.gov.au
Facsimile No. +61 2 6283 7999

Authorized officer
MLADEN MITIC
AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
Telephone No : +61 2 6283 3193

INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2010/000160

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Genc, V. et al.: "IEEE 802.16J Relay-Based Wireless Access Networks: An Overview," Wireless Communications, IEEE, Volume 15, p.56-63, 2008 - Pages 59, 60	3

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/MY2010/000160

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member
US 2009003298	US 2009003291
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.	
END OF ANNEX	