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— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

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(54) Title: A GROUP SHARED DISTRIBUTED RESERVATION PROTOCOL

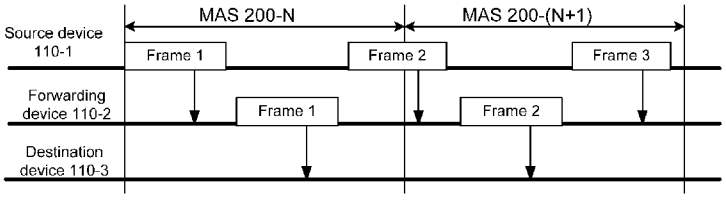

Figure 5

(57) Abstract: A method (400) for creating a group shared distributed reservation in a wireless network. The method comprises collecting information about the distributed reservation availabilities of devices in the wireless network (S410); selecting a group of shared devices to be included in the group shared distributed reservation based on the collected information (S420); sending a reservation request to each device in the group of shared devices (S430); and updating the group of shared devices to include only devices that accept the reservation request (S460), thereby creating a group shared distributed reservation of medium access time slots.

A GROUP SHARED DISTRIBUTED RESERVATION PROTOCOL

This application claims the benefit of U.S. Provisional Application No. 61/084,071 filed on July 28, 2008.

The invention generally relates to block transmission techniques.

A distributed reservation protocol (DRP), defined as part of the wireless media (WiMedia) medium access control (MAC) specification, provides a mechanism for concurrent communications between devices connected in a WiMedia based wireless network. To this end, devices allocate time slots, also referred to as medium access slots (MAS), before transmitting data. The DRP allows defining a set of rules to establish, modify, maintain, release, and terminate MAS unicast and multicast reservations. A unicast reservation includes a reservation owner and a reservation target, while a multicast reservation consists of a single reservation owner and multiple reservation targets. All the targets have a multicast address and the reservation owner simultaneously sends traffic to all its targets.

In some cases, data traffic sent from a source device to a destination device passes through one or more intermediate links before the data arrives at the destination device. For example, in a wireless network 100 shown in Figure 1, traffic from a source device 110-1 is sent over a link (hop) 120-12 to a forwarding device 110-2 and over a link 120-23 to a destination device 110-3. A multihop transmission is required when a source device cannot directly reach a destination device or when only low data rates are supported over a direct link between a source and destination device.

For such multihop transmissions, the DRP reserves a MAS for each link, while restricting the size of data frames and the MASs that can serve the transmission. As a result, there is at least one idle period at the end of each MAS for each hop of a multihop communication. As illustrated in Figure 2 a MAS 200-N (where N is an integer number) is reserved for the link 120-12 and a MAS 200-(N+1) is reserved for the 120-23 link. In addition, there is an idle

period 210 between the MASs 200-N and 200-(N+1), as data frame transmissions do not cross boundaries of a MAS, i.e., a reservation block. The DRP governs that a data frame received at the forwarding device 110-2 should wait for MAS 200-(N+1) to start prior to transmitting data to the destination device 110-3. This significantly increases the end-to-end latency between a source device and a destination device.

Therefore, it would be advantageous to provide a mechanism for reducing the latency of multihop transmissions in WiMedia based wireless networks.

Certain embodiments of the invention include a method for creating a group shared distributed reservation in a wireless network. The method comprises collecting information about the distributed reservation availabilities of devices in the wireless network; selecting a group of shared devices to be included in the group shared distributed reservation based on the collected information; sending a reservation request to each device in the group of shared devices; and updating the group of shared devices to include only devices that accept the reservation request, thereby creating a group shared distributed reservation of medium access time slots.

Certain embodiments of the invention also include a method for medium access control (MAC) layers forwarding in a wireless network. The method comprises collecting link quality information about each wireless link between a source device and its neighbour devices; collecting information about the distributed reservation availabilities of the neighbour devices; selecting a group of devices to participate in the MAC layers forwarding based on the collected information; creating a group shared distributed reservation of medium access time slots, wherein the group shared distributed reservation includes devices selected to participate in the MAC layers forwarding.

Certain embodiments of the invention further include a device forming a frame structure of a group shared distributed reservation protocol information element (GSDRP-IE) for transmission over a wireless network, wherein the GSDRP-IE includes: an element ID field having a predefined value indicating

that the GSDRP-IE is an information element of a group shared distributed reservation; a control field including a stream index and a distributed reservation availability information element (IE) request; a plurality of address fields including addresses of devices to which the GSDRP-IE is targeted; and a length field designating the size of the control field and addresses fields.

The subject matter that is regarded as the invention is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features and advantages of the invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings.

Figure 1 is a schematic diagram of a wireless network.

Figure 2 is a diagram illustrating MAS reservations for multihop communication.

Figure 3 is a schematic diagram of a group shared DRP information element construed in accordance with an embodiment of the invention.

Figure 4 is a flowchart illustrating a reservation negotiation process implemented in accordance with an embodiment of the invention.

Figure 5 is a diagram illustrating the process of MAS reservations for multihop communication using GSDRP.

Figure 6 is a diagram illustrating a fast MAC layers forwarding process performed using the GSDRP.

Figure 7 is a flowchart describing the fast MAC layers forwarding process implemented in accordance with an embodiment of the invention.

It is important to note that the embodiments disclosed by the invention are only examples of the many advantageous uses of the innovative teachings herein. In general, statements made in the specification of the present application do not necessarily limit any of the various claimed inventions. Moreover, some statements may apply to some inventive features but not to others. In general, unless otherwise indicated, singular elements may be in

plural and vice versa with no loss of generality. In the drawings, like numerals refer to like parts through several views.

A group shared distributed reservation protocol (DRP) including information elements and reservation rules are disclosed in accordance with certain embodiments of the invention. The group shared DRP can be utilized to reduce the end-to-end latency in wireless networks and, particularly in WiMedia based wireless networks. More specifically, the group shared DRP disclosed herein can be adapted to reduce the latency of multihop transmissions in WiMedia based wireless networks.

The cornerstone of the group shared DRP is an information element (IE) (hereinafter "GSDRP-IE") construed in accordance with the principles of the invention. As shown in Figure 3, a GRDRP-IE 300 includes an element ID field 310 having a predefined value indicating that the GSDRP-IE 300 is an information element of the group shared DRP, a length field 320, a control field 330, a number of M device address fields (collectively referred to as 340) to include the addresses of the devices to which the GSDRP-IE 300 is sent. The length field 320 specifies the size, i.e., number of bytes of the control 330 and address 340 fields. The control field 330 holds control information which includes, but is not limited to a stream index and a DRP availability IE request. The stream index is used to uniquely indicate the traffic flow that the GSDRP-IE 300 serves. The DRP availability information element (IE) request indicates whether or not devices should reply with their DRP availability IEs. In one embodiment of the invention, the value of the DRP availability IE request may be one of the values listed in Table 1.

Value (2 bits)	Description
00	Does not request DRP Availability IE
01	Request DRP Availability IEs from devices in address fields 340
10	Request DRP Availability IEs from all neighbour

	devices
11	Reserved

Table 1

Figure 4 shows a non-limiting and exemplary flowchart 400 illustrating the reservation negotiation process implemented in accordance with an embodiment of the invention. The purpose of the negotiation process is to reserve a MAS for data transmissions between two devices. Two different information elements may be utilized in this process: the GSDRP-IE (e.g., a GSDRP-IE 300) and a standard DRP-IE which is defined in current versions of the DRP specification. At S410, an initiating device collects DRP availabilities of one or more devices to be included in the group shared DRP reservation. To this end, a GSDRP-IE is sent to the devices where the DRP availability IE request (in the control field 330) is set to either one of the values “01” or “10”, depending on whether the availability request is from devices designated in the addresses field 340 or from neighbour devices of the initiating device. A device receiving an availability request responds back with its DRP availability IE indicating whether or not the device can reserve a MAS to the initiating device.

At S420, the initiating device selects a group of devices to be included in the group shared DRP reservation based on the collected availability information. The addresses of the selected devices are designated in a newly created GSDRP-IE. At S430 the newly created GSDRP-IE together with a standard DRP-IE are sent to all devices in the group. The GSDRP-IE and DRP-IE include the same value for their individual stream index sub-fields, which are part of the control fields of the IEs.

At S440, each device receiving the DRP-IE and GSDRP-IE checks if both IEs are valid. The check may include if both IEs have the same stream index value and if the GSDRP-IE includes the receiving device address. If both checks result in an affirmative answer, then at S450, the receiving device responds with a DRP-IE indicating if the reservation request is rejected or

accepted. If the reservation request does not conflict with other existing reservations, the receiving device grants the reservation; otherwise, the receiving device denies the reservation. Specifically, when a reservation is granted, the receiving device indicates the acceptance of the reservation by sending back a DRP-IE having the same reservation status as in the received DRP-IE. A rejected reservation is indicated by specifying in the reservation status that the reservation has not been established.

If one of the checks performed at S440 results in a negative answer, at S445, the receiving device denies the reservation. At S460, all DRP-IE replies sent from devices are received at the initiating device, and the group is updated to include only devices that accepted the reservation request.

It should be appreciated that by creating a group shared DRP reservation, it allows transmitting data between devices without any idle periods and more data frames can be sent during a single MAS. Referring back to the example shown in Figure 2, the invention can be utilized to reduce the latency by creating a shared group of DRP reservations including the forwarding and destination devices 110-2 and 110-3 where the source device 110-1 is the initiating device. As shown in Figure 5, three data frames can be sent during MASs 200-N and 200-(N+1), where no idle periods are required between frame transmissions. In addition, a frame received at the forwarding device 110-2 does not wait for start of the MAS 200-(N+1) for transmitting data to the destination device 110-3.

The negotiation process described above is only one process provided as part of the process for performing DRP reservation for a group of devices as disclosed according to certain embodiments of the invention. Other processes may include, but are not limited to, modifying and terminating a group shared DRP reservation.

To terminate a group shared DRP reservation, the reservation owner (i.e., initiating device) removes or stops sending the DRP-IE and the GSDRP-IE to

devices in the group. As a result, all devices in the group stop sending their corresponding DRP-IEs.

In accordance with certain embodiments of the invention a standard DRP reservation and an existing group shared DRP reservation can be modified. Specifically, a reservation owner of a unicast/multicast DRP reservation can modify the reservation to a group shared DRP reservation. This is performed by selecting devices to join an existing DRP reservation based on their availability. Then, a reservation owner sends a GSDRP-IE with the value of the stream index field the same as that of the DRP-IE for the DRP reservation. The selected devices are included in the address fields (e.g., field 340) of the GSDRP-IE. Each device receiving the GSDRP-IE and DRP-IE can accept or reject the request to join an existing DRP reservation using the process described in detail above.

A reservation owner can also modify a DRP reservation (i.e., a reserved MASs) by changing the group of devices assigned with the reservation. With this aim, the reservation owner first determines the devices to be included in the modified group. Then, the address fields (e.g., fields 340) in the corresponding GSDRP-IE are modified to designate the addresses of only devices in the new group. A device that is removed from the group stops sending a corresponding DRP-IE, no longer associated with the established reservation. A device that is newly added into the GSDRP-IE joins the established reservation by setting an acceptance status when responding with its DRP-IE. An acceptance status is sent only if the reservation does not conflict with other existing reservations; otherwise, the device rejects the established reservation by setting a reject status in the responding DRP-IE.

In accordance with another embodiment of the invention the group shared DRP can be utilized to implement a fast MAC layers forwarding process. As illustrated in Figure 6, this process allows forwarding devices in the group to forward a data frame one after another in a single MAS and also to transmit multiple data frames in the same MAS.

Figure 7 shows an exemplary and non-limiting flowchart 700 describing the fast MAC layers forwarding process implemented in accordance with an embodiment of the invention.

At S710, a source device requests link quality information about wireless links with its neighbor devices. At S720, the source device requests its neighbors to send their DRP availability as described above. At S730, based on the link quality information and DRP availability of devices, the source device selects a group of devices to participate in the fast MAC layer forwarding. At S740, a source device either initializes a new group shared DRP reservation or modifies an existing reservation between itself and its target device or by using the selected group of devices. When a reservation is established or successfully modified, the reserved MAS can be used for the fast MAC layer's forwarding.

The group shared DRP reservation method and information elements described herein can be implemented in communication systems including, but not limited to, a UWB based wireless personal area networks (PANs), WiMedia based wireless networks, or any time division multiple access (TDMA) or super-frame based wireless networks.

The foregoing detailed description has set forth a few of the many forms that the invention can take. It is intended that the foregoing detailed description be understood as an illustration of selected forms that the invention can take and not as a limitation to the definition of the invention. It is only the claims, including all equivalents that are intended to define the scope of this invention.

Most preferably, the principles of the invention are implemented as a combination of hardware, firmware and software. Moreover, the software is preferably implemented as an application program tangibly embodied on a program storage unit or computer readable medium. The application program may be uploaded to, and executed by, a machine comprising any suitable architecture. Preferably, the machine is implemented on a computer platform having hardware such as one or more central processing units ("CPU"), a

memory, and input/output interfaces. The computer platform may also include an operating system and microinstruction code. The various processes and functions described herein may be either part of the microinstruction code or part of the application program, or any combination thereof, which may be executed by a CPU, whether or not such computer or processor is explicitly shown. In addition, various other peripheral units may be connected to the computer platform such as an additional data storage unit and a printing unit.

Claims

I claim:

1. A method (400) for creating a group shared distributed reservation in a wireless network, comprising:

collecting information about distributed reservation availabilities of devices in the wireless network (S410);

selecting a group of shared devices to be included in the group shared distributed reservation based on the collected information (S420);

sending a reservation request to each device in the group of shared devices (S430); and

updating the group of shared devices to include only devices that accept the reservation request (S460), thereby creating a group shared distributed reservation of medium access time slots.

2. The method of claim 1, wherein collecting the information about distributed availabilities of devices comprises sending a group shared distributed reservation protocol information element (GSDRP-IE) (300) to the devices in the network.

3. The method of claim 2, wherein the GSDRP-IE includes at least: an element ID field (310) having a predefined value indicating that the GSDRP-IE is an information element of a group shared distributed reservation, a control field (330) including a stream index and a distributed reservation availability information element (IE) request, a plurality of address fields (340) including the addresses of the devices to which the GSDRP-IE is sent, and a length field (320) designating the size of the GSDRP-IE.

4. The method of claim 3, wherein selecting the group of shared devices comprises creating a new GSDRP-IE to include an address of each selected device.

5. The method of claim 4, wherein sending the reservation request comprises sending the new GSDRP-IE and a DRP-IE to each device in the group shared devices.

6. The method of claim 5, wherein each device receiving the GSDRP-IE and the DRP-IE performs:

checking if the new GSDRP-IE and the DRP-IE are valid (S440); and

responding with a DRP-IE indicating whether the reservation request is rejected or accepted (S450).

7. The method of claim 1, further comprising terminating the group shared distributed reservation.

8. The method of claim 1, further comprising modifying the group shared distributed reservation.

9. The method of claim 1, wherein the wireless network is at least a WiMedia based network.

10. A computer readable medium having stored thereon computer executable code causing a processor to perform the process of creating a group shared distributed reservation in a wireless network, comprising:

collecting information about distributed reservation availabilities of devices in the wireless network (S410);

selecting a group of shared devices to be included in the group shared distributed reservation based on the collected information (S420);

sending a reservation request to each device in the group of shared devices (S430); and

updating the group of shared devices to include only devices that accept the reservation request (S460), thereby creating a group shared distributed reservation of medium access time slots.

11. A method (700) for medium access control (MAC) layers forwarding in a wireless network, comprising:

collecting link quality information about each wireless link between a source device and the source device's neighbour devices (S710);

collecting information about distributed reservation availabilities of the neighbour devices (S720);

selecting a group of devices to participate in the MAC layers forwarding based on the collected information (S730);

creating a group shared distributed reservation of medium access time slots (S740), wherein the group shared distributed reservation includes the devices selected to participate in the MAC layers forwarding.

12. The method of claim 11, further comprising modifying an existing group shared distributed reservation to include the selected devices.

13. The method of claim 11, wherein the MAC layers forwarding allows transmitting a plurality of data frames from the source device to a destination device through one or more forwarding devices during a single medium access time slot, wherein the source device, the destination device, and the one or more forwarding devices are in the group shared distributed reservation.

14. A computer readable medium having stored thereon computer executable code when executed causing a processor to perform the process of medium access control (MAC) layers forwarding in a wireless network, comprising:

collecting link quality information about each wireless link between a source device and the source device's neighbor devices (S710);

collecting information about distributed reservation availabilities of the neighbor devices (S720);

selecting a group of devices to participate in the MAC layers forwarding based on the collected information (S730);

creating a group shared distributed reservation of medium access time slots, wherein the group shared distributed reservation includes the devices selected to participate in the MAC layers forwarding (S740).

15. A device forming a frame structure of a group shared distributed reservation protocol information element (GSDRP-IE) (300) for transmission over a wireless network, wherein the GSDRP-IE includes:

an element ID field (310) having a predefined value indicating that the GSDRP-IE is an information element of a group shared distributed reservation;

a control field (330) including a stream index and a distributed reservation availability information element (IE) request;

a plurality of address fields (340) including addresses of devices to which the GSDRP-IE is targeted; and

a length field (320) designating the size of the control field and addresses fields.

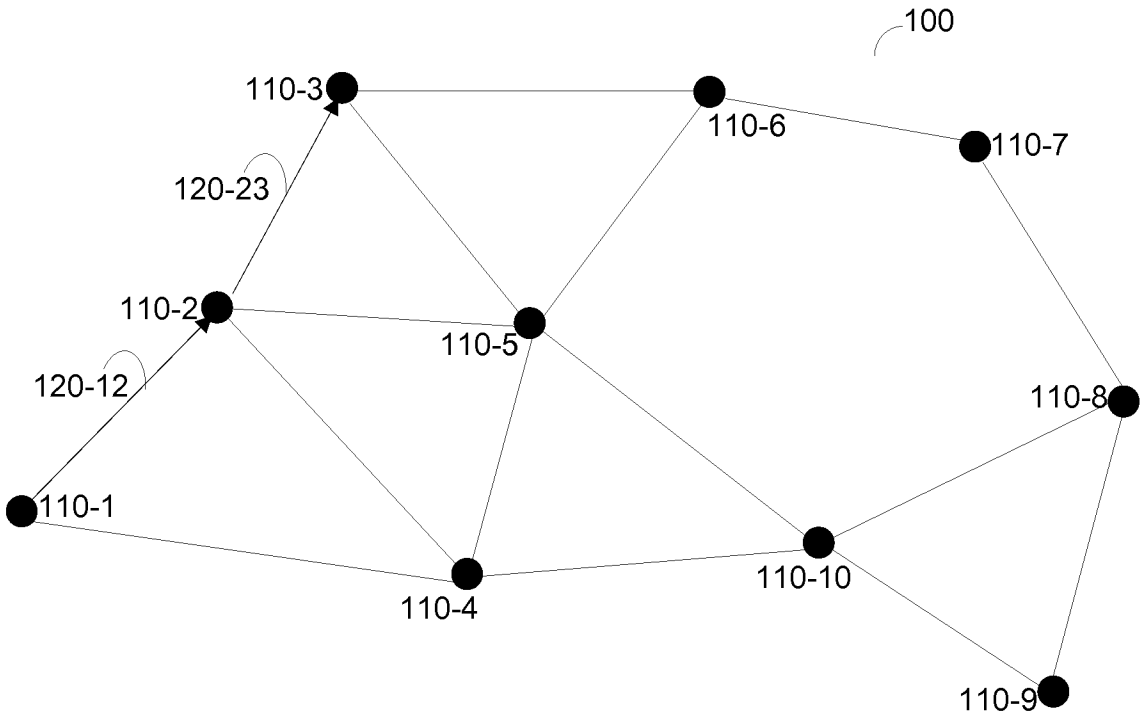

Figure 1

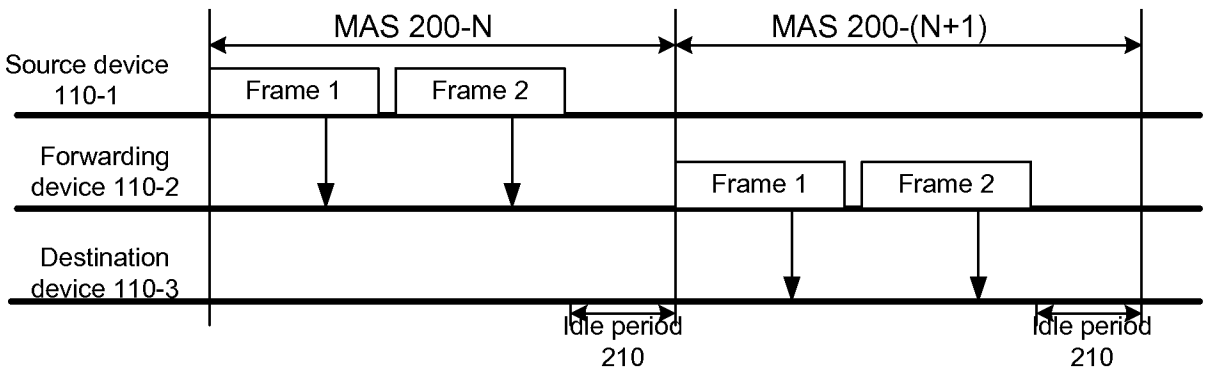

Figure 2

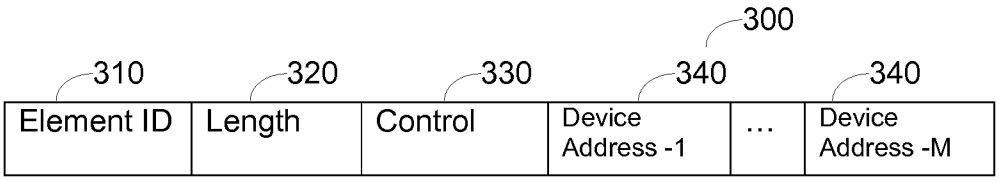
300
310
320
330
340
340
Element ID
Length
Control
Device Address -1
…
Device Address -M

Figure 3

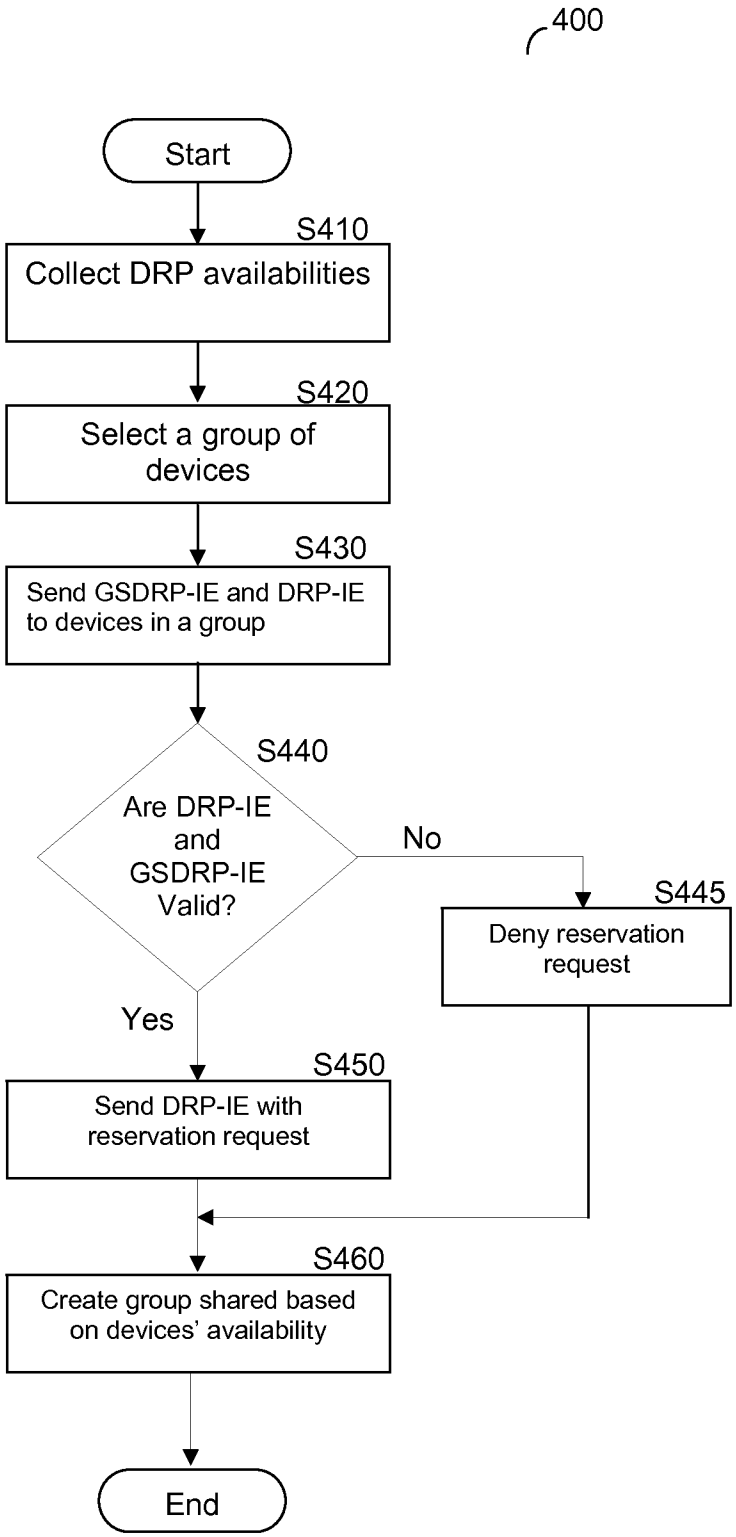
400
Start
S410
Collect DRP availabilities
S420
Select a group of devices
S430
Send GSDRP-IE and DRP-IE to devices in a group
S440
Are DRP-IE and GSDRP-IE Valid?
No
S445
Deny reservation request
Yes
S450
Send DRP-IE with reservation request
S460
Create group shared based on devices' availability
End

Figure 4

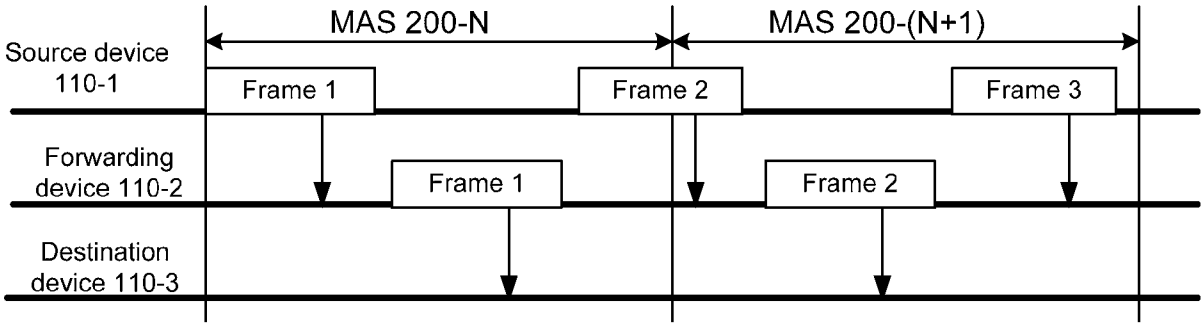

Figure 5

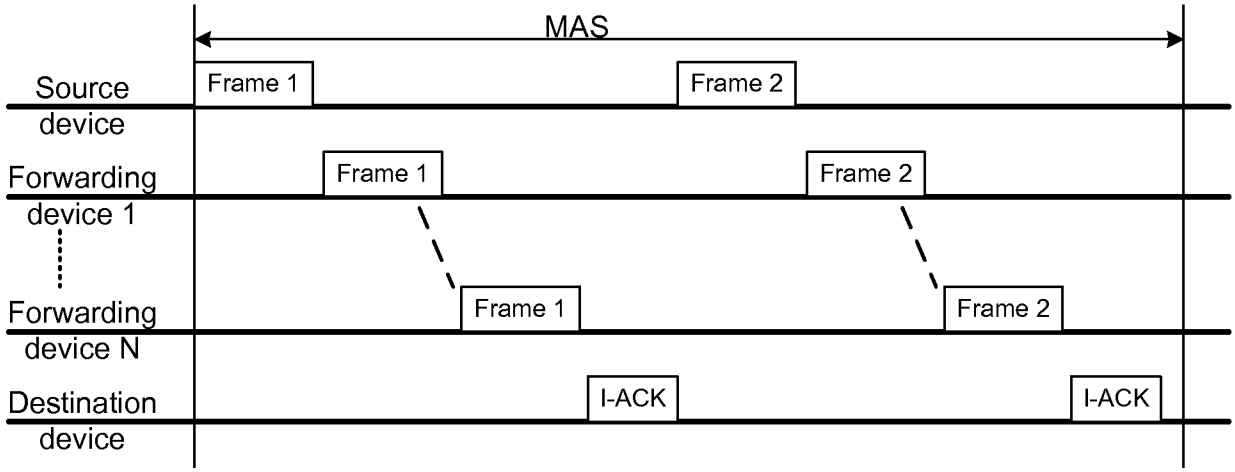

Figure 6

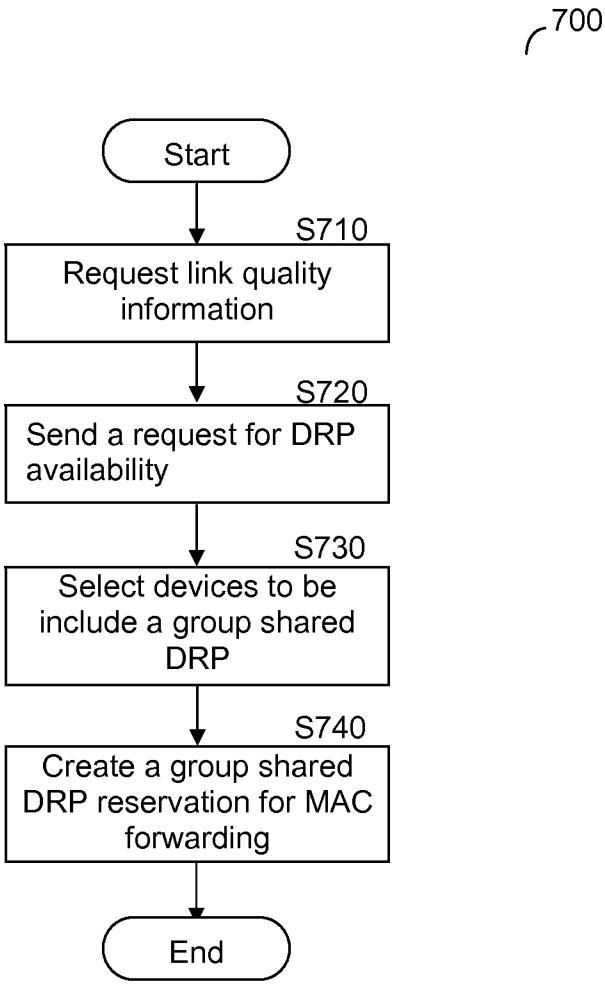
700
Start
S710
Request link quality information
S720
Send a request for DRP availability
S730
Select devices to be include a group shared DRP
S740
Create a group shared DRP reservation for MAC forwarding
End

Figure 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/052975

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W28/26

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

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, 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	"High Rate Ultra Wideband PHY and MAC Standard" INTERNET CITATION, [Online] XP002460171 Retrieved from the Internet: URL:http://www.ecma-international.org/publications/files/ECMA-ST/ECMA-368.pd> [retrieved on 2007-11-28]	1-10,15
Y	table 100 paragraphs [16.5.1] - [16.5.3] paragraphs [16.8.6] - [16.8.7] paragraph [16.8.18] paragraphs [17.1.10.5] - [17.1.10.6] paragraph [17.1.10.13] pages 200-206, paragraph 17.4	11-14

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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

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"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

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"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	Date of mailing of the international search report
28 October 2009	05/11/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Hegeman, Hans

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/052975

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 03/090083 A (MESHNETWORKS INC [US]; SCHMIDT JEFFREY C [US]; WHITE ERIC D [US]) 30 October 2003 (2003-10-30) paragraphs [0033], [0034]	11-14
X	WO 2005/076544 A (KONINKL PHILIPS ELECTRONICS NV [NL]; HABETHA JOERG [DE]; HIERTZ GUIDO) 18 August 2005 (2005-08-18) page 2, line 21 - page 4, line 20 page 8, line 16 - page 10, line 29 page 12, line 27 - page 14, line 23 page 17, line 13 - page 20, line 6 page 21, lines 22-29 page 22, lines 3,4,28,29	1-10,15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2009/052975

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