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GB 2260467 A EP 0145983 A2 WO 95/24655 A2

(58) Field of Search

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INT CL⁶ H04B 7/14 7/145 7/15 7/155 7/204 7/26
On-Line: WPI**

(54) **Direct mode communications repeater**

(57) A repeater 3, for direct mode communication, builds up a database of broadcast information which may then be used to periodically transmit data relating to past, present, and possibly future channel usage to mobile stations 1,5,9,7 capable of monitoring the direct mode channel. This broadcast information may be transmitted during preset frames of a TDM system or during periods of inactivity of the repeater. The information is intended for example to inform users on the direct mode channel of groups or individuals who have used the channel recently and, if desired, the time since last transmission, thus providing an indication that such users still may be within the coverage area of the repeater and therefore contactable.

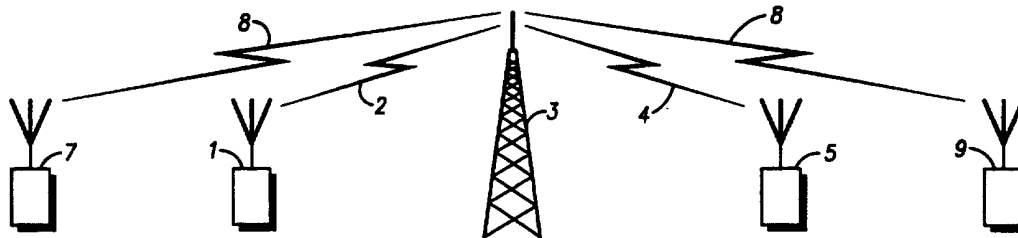


FIG. 1

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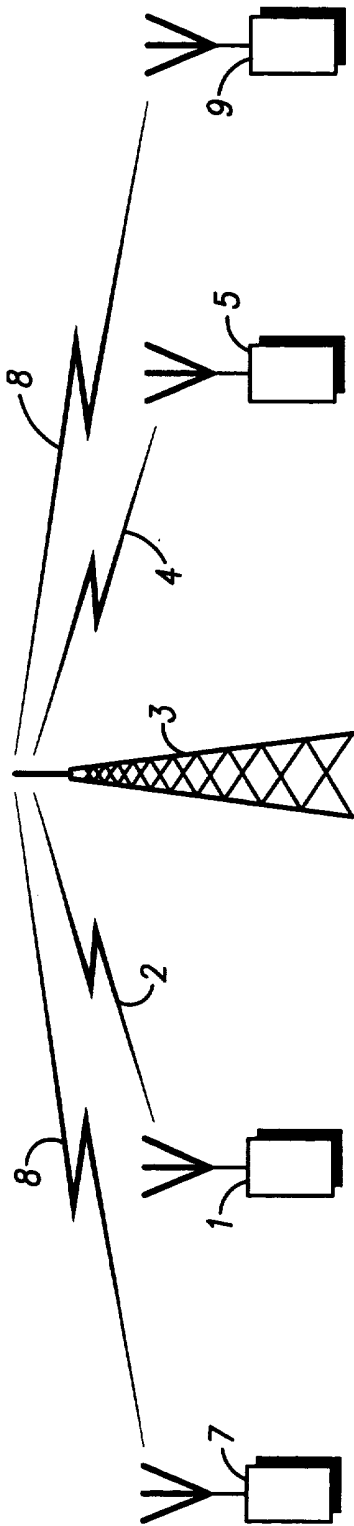


FIG. 1

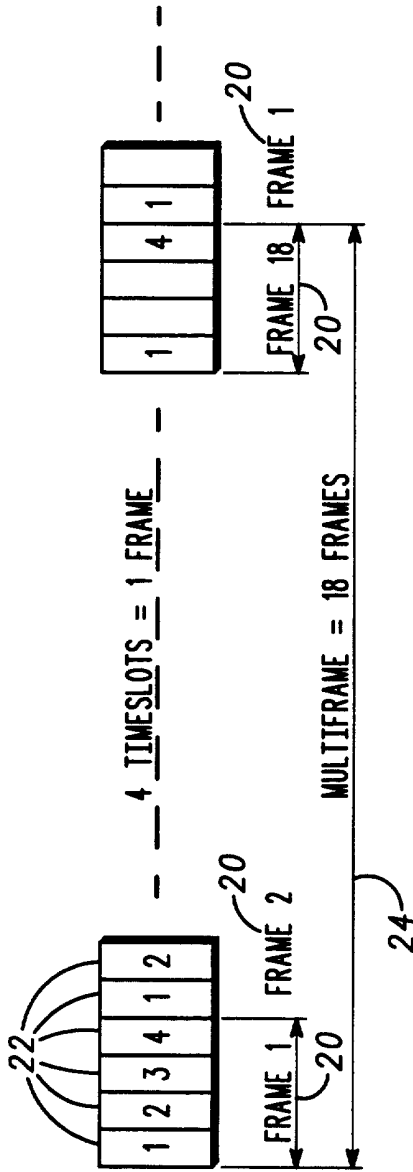


FIG. 2
OVERALL SLOT AND FRAME STRUCTURE

31 Table A:
DMAC SYNCH PDU contents in sch/s (60 bits)

Information element	Length (bits) [m,c]	Remark
system code	4[m]	
35 sync pdu type	2[m]	00=dmac sync from MS 01=dmac sync from REP 10=dmac sync from GW 11=reserved
communication type	2[c]	included if pdu type=00 direct MS-MS comm MS comm via REP MS comm via Gateway MS comm via REP/Gateway
channel state	2[c]	included if pdu≠00 00 channel idle 01 channel occupied 10 channel reserved 11 reserved
master/slave link	1[m]	1=master link 0=slave link
channel A/B	1[m]	1=channel A 0=channel B
slot number	2[m]	
frame number	5[m]	
AI encryption state	2[m]	
AI related info	39[c]	
Reserved	2[m]	

30

33 Table B:
DMAC SYNCH PDU contents for sync pdu type=01 (124 bits)

Information element	Length (bits) [m,c]	Remark
40 repeater address	10[m]	as per standard
42 repeater power class	2[m]	00=class 1 01=class 2 10=class 3 11=class 4
44 single freq/two freq op	1[m]	
46 mobile network id	24[m]	
48 repeater message type (included to support enhanced information service)	5[m]	REP layer 2 message type e.g. recent user id e.g. new calls waiting e.g. new call requests e.g. MS presence requests
49 repeater information	82[c]	REP message type dependent information

FIG. 3

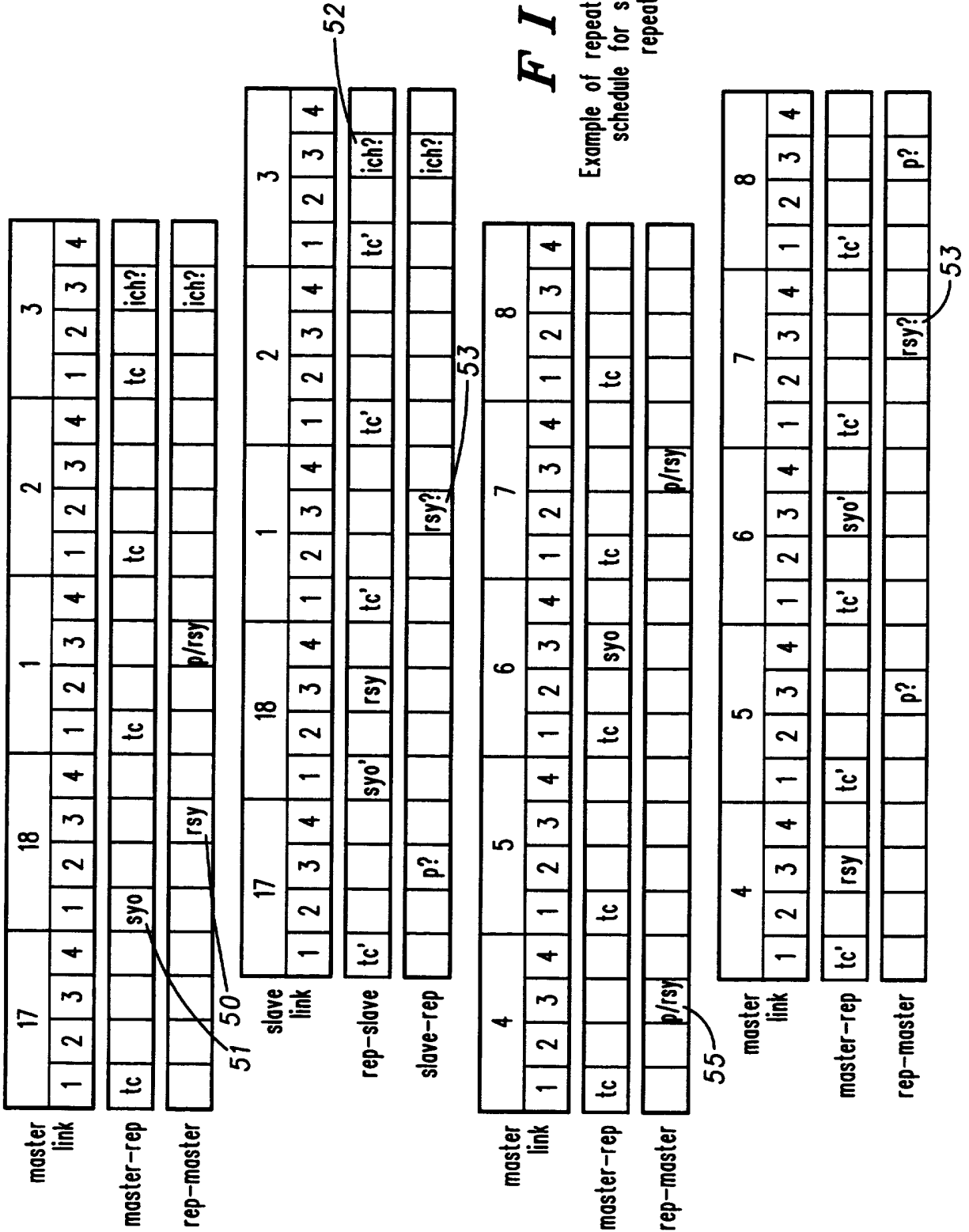


FIG. 4

Example of repeater broadcast signaling schedule for single frequency DM repeater option

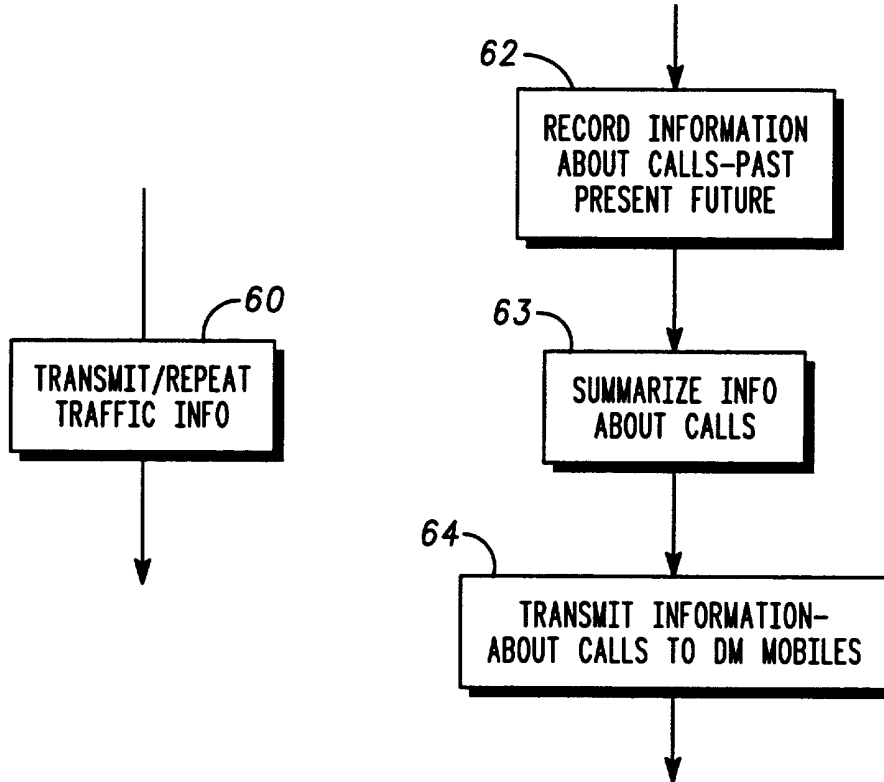


FIG. 5

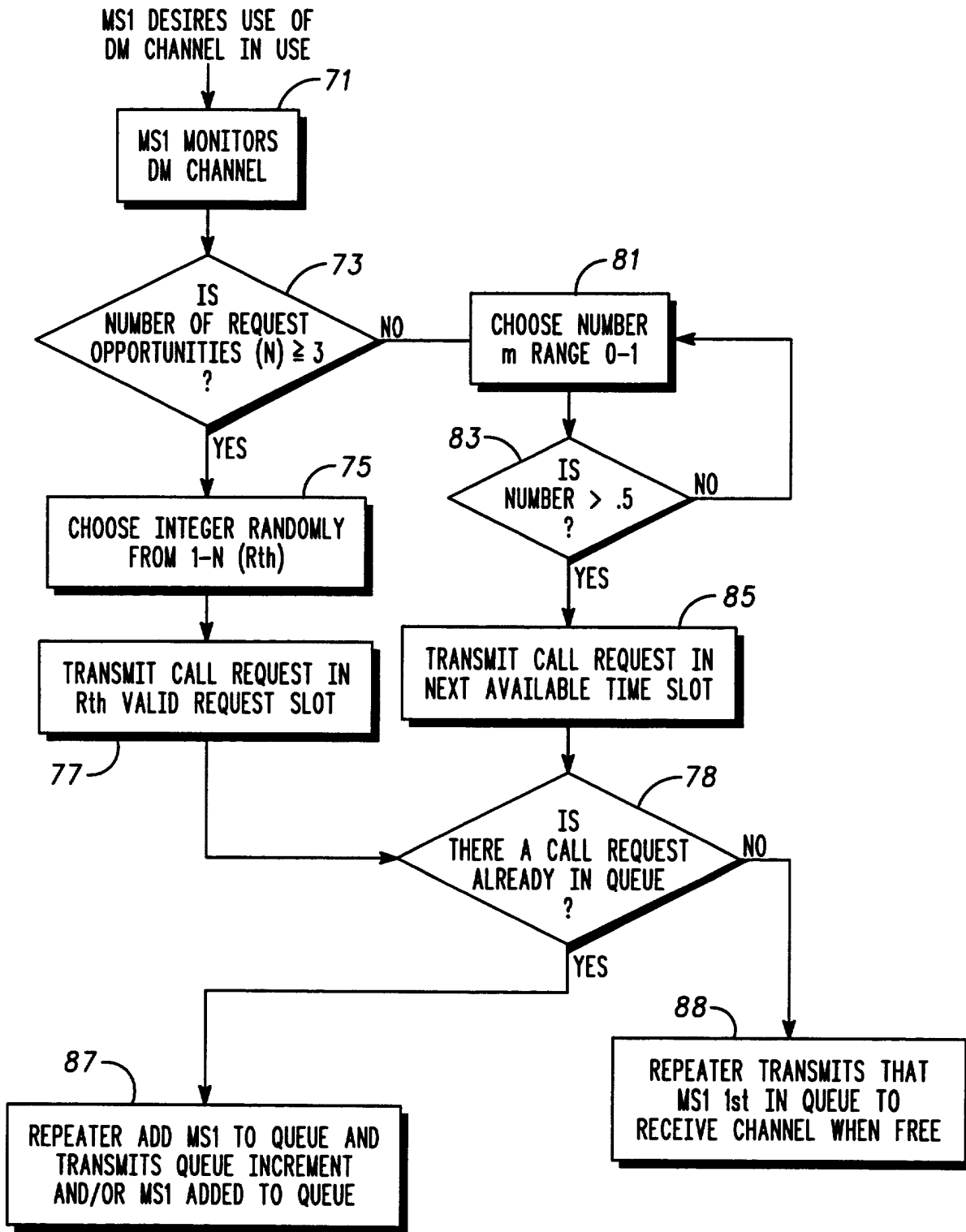


FIG. 6

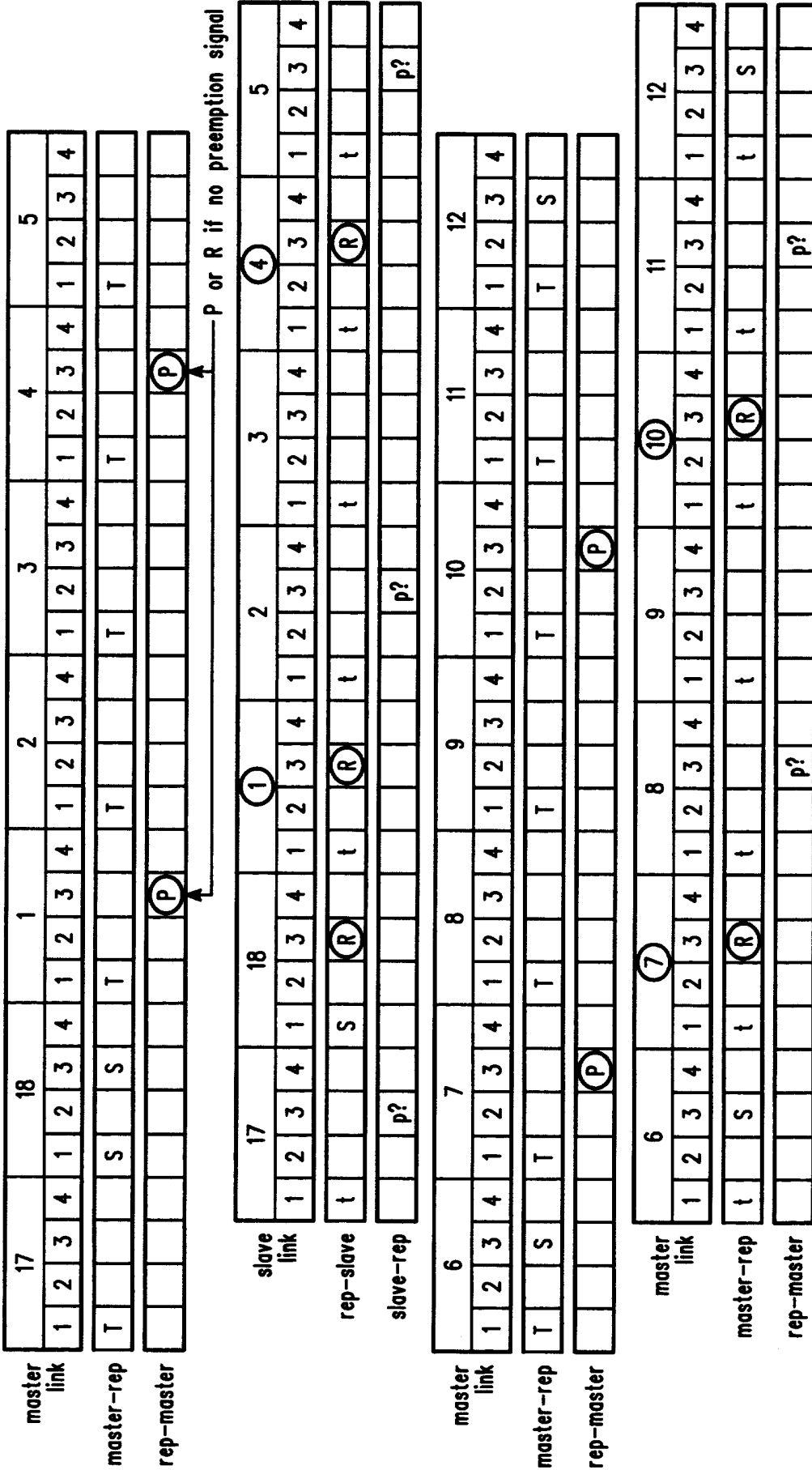


FIG. 7A

Example of single frequency repeater broadcast signalling
 * Repeater broadcast sent on slave link frames 1, 4, 7, 10,...

COMMUNICATIONS REPEATER AND METHOD OF OPERATION
THEREFOR

Field of the Invention

5 This invention relates in general to a repeater for a direct mode communication and more particularly a signalling scheme for the repeater to provide non-call related information.

Background to the Invention

10 In radio communications, operating with no fixed network control, e.g. conventional or direct mode operation, repeaters have typically been used to extend the coverage of the mobile to mobile communication range. For instance, a mobile may transmit to a repeater for retransmission, after decoding and error correction, to a second mobile. The second mobile may
15 have been out of transmitting range of the first mobile without the use of the repeater.

 A direct mode repeater thus provides a service for direct mode radios wishing to communicate over an enlarged direct mode coverage area. Repeaters decode, error correct and re-encode the information it receives
20 from a transmitting master mobile station prior to retransmission. Direct mode repeaters may operate using either a single frequency or two frequencies. Currently repeaters do not generate any signalling of their own, such as signalling information or control signalling.

 There is no mechanism in place for mobile stations operating for
25 direct mode communications to optimise the use of the direct mode resources. There are no signalling schemes for a direct mode repeater to form any type of a broadcast signal during primarily periods of channel inactivity and/or during periods of communications. In particular, for public shared network operators it is likely that repeaters will be installed in semi-
30 permanent or permanent locations with limited control capabilities. Lack of available signalling information may result in calls being jammed or never even set up. Drastically, communications become unreliable which is intolerable in the public safety market. Therefore, there is a need for a signalling scheme that allows an efficient operational procedure where all
35 mobiles operating on the direct mode channel are supplied by a repeater

with direct mode channel related information, or non-call related information.

Summary of the Invention

5 According to the present invention, a repeater for a direct mode communication is provided having a signalling scheme for providing non-call related information.

 A method is provided for providing non-call related information by a repeater for a direct mode communication including the steps of recording
10 non-call related information by the repeater about direct mode communications involving the repeater, summarising the non-call related information about the communications, and periodically transmitting the summarised non-call related information.

15 Brief Description of the Drawing

 FIG. 1 shows a repeater for direct mode communications.

 FIG. 2 shows a TDM frame and slot structure.

 FIG. 3 shows a signalling scheme according to an embodiment of the present invention.

20 FIG. 4 shows a signalling scheme for frames and time slots according to an embodiment of the present invention.

 FIG. 5 shows a method of operation for a repeater according to an embodiment of the present invention.

25 FIG. 6 shows a method of operation for a repeater according to an embodiment of the present invention.

 FIG. 7 shows a signalling scheme for frames and time slots according to an embodiment of the present invention.

Detailed Description of the Preferred Embodiment

30 The present invention provides a form of broadcast signalling or a signalling scheme or service in order to provide information which could be employed by mobile stations to optimise their use of the direct mode resources. In particular, the direct mode channel during periods of channel inactivity and during operation may be used to determine call set up,
35 random access, priority, recent user, next user information, etc.

The present invention proposes that during periods of channel inactivity or permitted (predetermined) time slots within the direct mode multiframe structure during traffic transmissions, the repeater shall provide broadcast information (or non-call related information) relating to present, 5 past and possibly future channel use to mobile stations capable of monitoring the direct mode channel. The information is intended for example to inform the users on the direct mode channel of groups or individuals who have used the channel recently and, if desired, the time since last transmission, thus providing an indication that such users still 10 may be within the coverage area of the repeater and therefore contactable.

FIG. 1 shows an example of a repeater 3 for a direct mode communications between at least a first mobile 1 and at least a second mobile 5. The master mobile or transmitting mobile 1 in the direct mode communications transmits information to the repeater 3 that is then 15 retransmitted to the receiving mobile 5. During periods of inactivity or transmission and according to a predetermined signalling scheme, the repeater may periodically transmit non-call related information to other mobiles 7, 9. Non-call related information is information not related to the actual traffic information. Traffic information may be defined as 20 information that is merely retransmitted after decoding, error correction and encoding whereas non-call information is information that pertains to communications resource history or future use that is organised and transmitted by the repeater to help co-ordinate communications.

In a TDM system, communication resources are divided into frames 25 20 that are further sub divided into time slots 22 as shown in FIG. 2. Eighteen frames comprise a multiframe 24. A particular communication resource may be a time slot on a particular radio frequency or channel. A communications resource may also be a repeater 3 as shown in FIG. 1. The present invention provides a repeater with a signalling scheme to broadcast 30 information that allows direct mode mobile stations to effectively manage communications resources.

To provide an embodiment of such a signalling scheme or capability, the repeater 3 may employ a message structure of the SYNC PDU as used in the TETRA (Trans European Trunked Radio standard as proposed by ETSI) 35 direct mode operation. Such message structure is transmitted in logical channels SCH/S + SCH/H. A possible repeater signalling scheme with

particular message structure which primarily only impacts the contents of the SCH/H channel is detailed in FIG. 3.

As shown in FIG. 3, by Table A 31 and Table B 33, the synch information is carried in two logical channels within a single burst. Table A 5 31 shows the first burst of information containing 60 bits. In the second field, the sync pdu type 35 is transmitted. The [m] means the field is mandatory whereas the [c] mean the field is optional. The present invention provides a field that allows an indication to be transmitted in the sync pdu type 35 that the transmitted information is non-call related information. 10 When the two bits in the second field are 01, shown as one of the alternatives 30, the transmitted information is repeater generated broadcast information or non-call related information.

The new field in the SCH/S part of the direct mode sync pdu distinguishes between master mobile station sync bursts retransmitted by 15 the repeater and broadcast bursts (or non-call related information) generated by the repeater. It is also proposed that the repeater could either indicate in normal repeated master synch bursts where in the future the next repeater broadcast channel will be sent e.g. in terms of number of frame durations from the current frame or the scheduling of the broadcasts 20 could be pre assigned in terms of which frames non-call related information is present in.

FIG. 3 Table B shows a signalling scheme with particular message structure including various means to convey different non-call related information. Assuming that the information capacity of the repeater 25 signalling scheme channel is 124 bits like the reference SCH\H in TETRA direct mode, the scheme may be set up as follows. The information element of the first field will include the repeater address 40 with a length of ten bits as per the standard requirement. The information element of the second field will be the repeater power class 42 having a length of two bits. The 30 third field indicates whether it is a single frequency or two frequency operation. The fourth field is the mobile network identification 46. The fifth field is the repeater message type 48 which is included to support the non-call related information signalling. For example, the message type is a layer two message type where the first layer indicates the type of message and the 35 second layer is the message or repeater information. The message type may indicate that the information field 49 to follow contains: a recent user

identification, new calls waiting, new calls requests, or mobile station presence requests. The sixth field is the repeater information 49 or the repeater message type dependent information. The repeater information field 49 is 82 bits.

5 Additional types of information may be provided in the repeater broadcast channel which may be scheduled on either a priority, recent user or first in first out basis. The information relating to a certain call may be cycled in time around the different broadcast bursts transmitted over a number of multi frames.

10 One method by which the repeater broadcast signal can be scheduled into direct mode multiframe timing structure is discussed below for two scenarios. One scenario is during a traffic call and the other scenario is when the channel is idle.

15 For the scenario when the channel is in a traffic communication. A proposed signalling schedule to accommodate the repeater broadcast signalling is outlined in FIG. 4 for repeater single frequency operation.

It is proposed where a direct mode repeater supports a repeater broadcast channel that during frame 18 of a traffic call, the repeater shall in time slot 1 retransmit the current master mobile station synchronisation information 51 in the normal manner. However in frame 18, time slot 3 the
20 repeater shall send a repeater broadcast message 50 which shall contain the direct mode channel related information or the non-call related information. More direct mode channel usage information may be transmitted in other pre assigned frames such as time slot 3 on the repeater to slave mobile
25 station link 52. Frames used for channel occupation signalling, i.e., frames 6 and 12 would be unavailable. The example in FIG. 4 permits the repeater to send the broadcast signal or non-call related information 55 in frames 4, 10, 14 and 18. Such a scheme permits opportunities for slave mobile stations to send non-call related information 53 in time slot 3 of frames 1, 7
30 and 13.

The master mobile station may be able to hear direct mode non-call related information that the repeater sends as the broadcast information during the pre-assigned master pre-emption slots when there is NO pre-emption signalling present. The slots supporting this operation are
35 indicated in FIG. 4 by p/rsy 55.

Also during channel reservation the repeater broadcast message 50 could be scheduled in a similar fashion to that described above for frame 18 time slot 3, and transmitted in those frames assigned for reservation signalling, frames 6, 12.

5 For the second scenario, when the direct mode channel is in idle mode, the scheduling of the repeater broadcast signal is much simpler. It may be that after every multiframe duration the repeater shall transmit a sequence of broadcast messages, for example, in every time slot of two consecutive frames. Such a signal provides:

10 1) synchronisation to all mobile stations that may operate on the direct mode channel via the repeater and indicate that the repeater is present on the channel; and/or

2) relevant information regarding use of the channel in the recent past or reserve channel for particular users in the near future.

15 An embodiment of the present invention, as shown in FIG. 5, includes a method for a providing non-call related information by a repeater for a direct mode communication comprising the steps of recording non-call related information by the repeater about direct mode communications involving the repeater 62, summarising the non-call related information about the
20 communications 63, and periodically transmitting the non-call related communications 64. The repeater may be also be involved a traffic call, a direct mode repeater operation of simultaneously transmitting repeated traffic as in step 60.

In the present invention, the information required to manage the
25 radio resource efficiently is made available to each direct mode subscriber. The present invention uses the fact that all calls going through the repeater are gathered and summarised so that information required to use the radio resource more efficiently is transmitted to mobile stations so that the mobile stations can make decisions on using the radio resource.

30 Whereas, base stations manage the radio system, a repeater according to the present invention provides information for mobiles to manage the radio resource themselves (self-trunking, not centrally managed) more efficiently than in typical direct mode operation.

Specifically, FIG. 6 describes one example of non-call related
35 information as call request queuing. As shown in FIG. 6, when a mobile station desires the use of a direct mode channel after the current user,

the mobile station monitors the direct mode channel as in step 71. The mobile station monitors the repeater broadcast channel to determine whether any new calls are currently in the queue (may be indicated in new calls waiting field). If no new calls are queued then the mobile shall
5 send a channel request message to the repeater during those frames time slot assigned for such a purpose by the repeater. The repeater may also indicate in the current signalling message which future time slots may be used for new call requests, e.g., this could be achieved using a bit map.

10 If the call request is not made in the next available signalling slot opportunity, a simple random access procedure may be employed to minimise collisions of call queue requests as shown in FIG. 6. The signalling slot opportunity to be used for the request is selected as follows. If the number of request opportunities per multiframe duration
15 is equal to or greater than 3, as determined in step 73, then the mobile shall choose an integer R randomly from the range 1-3 (using an uniform distribution), step 75, and shall transmit the request in the Rth valid request slot, step 77.

20 If the number of opportunities per multiframe is less than 3 as determined in step 73 then the mobile shall choose a number in the range 0-1 (using a uniform distribution), step 81, and if the number is greater than 0.5 as determined in step 83 it shall transmit in the next available request slot, step 85. In the case where the number selected is less than or equal to 0.5 as determined in step 83, then mobile shall
25 repeat the above exercise for the next request opportunity, step 81. If after 3 attempts the mobile has not made a request transmission it shall do so at the next request opportunity.

The channel request message should contain the address of the called party and either calling party address or if bit budget is limited a
30 call id generated by the calling mobile station to identify the call request. The repeater shall then if no other new call requests were received during this time, transmit this information during a signalling channel transmission indicating that it has been received and that the requesting mobile will have first use of the channel when it goes free,
35 step 88.

When the mobile monitors the broadcast channel and sees a new call is already queued as in step 78 then it may still send in a new call request, in this case the repeater may not change the next calling party but may indicate that another call request was received by incrementing the new call waiting value, step 87.

It may also be provided that the new call request must be updated periodically to indicate that the channel is still required. In order not to have contention on the channel it may possible for the repeater to reserve a time slot for each queued mobile to send in such a refresh request.

During idle channel operation, mobile stations may send in a dummy call request to a repeater in order to have its preferred GTSI (to keep numbers down unlikely that ITSI would be used) transmitted on the repeater signalling channel. This would enable other mobiles to know approximately whether member(s) of a particular group are present within the coverage area of the repeater.

Such a process may be used by a mobile to indicate his presence within the coverage area of the repeater by sending in the "dummy" group call set-up request to the repeater during the time when the channel is idle. The repeater would then relay this information, thus providing a mechanism to indicate that a particular group member is listening to the direct mode channel. Currently there is no way in direct mode to ensure at least one member of a group is listening to a transmission.

Call set-up request during direct mode channel in traffic for signalling according to an embodiment of the present invention is outlined in FIG. 7 for repeater single frequency operation. A similar approach may be employed for two frequency repeater operation. In FIG. 7, T represents traffic from master mobile station to repeater; t represents retransmit of traffic by repeater to slave; S represents synch information sent by master mobile station related to ongoing call; R represents repeater broadcast signalling; P? represents pre-emption signalling opportunity (slave link); P represents pre-emption signalling or broadcast signalling (master link); and N represents new (future/next) call request opportunity.

This embodiment relies upon the fact that during periods of channel inactivity or the permitted (pre-determined) time slots within the direct mode multiframe structure during traffic transmissions, the repeater provides non-call related information relating to present, past and in this case FUTURE direct mode-channel use to mobile stations capable of monitoring the direct mode channel.

Such non-call related information may inform users on the direct mode channel of groups or individuals who have used the channel recently and if required the time since last transmission or who will have the channel next.

The repeater serves as a central repository of the queue information, and makes the information about the queue available to the mobile stations. The mobile stations may effectively manage the queue themselves.

There are two sources of information for the repeater. The traffic information that the repeater is repeating; i.e., as the repeater repeats slots of information, it extracts information about the call, such as the sending mobile address and the destination mobiles individual or group address, and records the addresses with a time stamp in its data base. For this source of information, the mobile, isn't sending a message to the repeater, the repeater is extracting information from a message destined for someone else.

The second source of information is specific signalling messages sent from a mobile station to the repeater, which the repeater then logs in its data base. For example, a mobile station entering the area might send its identity to the repeater, which then logs that information, and sends it out in the non-call relating signal. This would be an individual presence check initiated and managed by the mobile, but facilitated by the repeater non-call related signalling.

The information provided in the repeater broadcast channel may be scheduled on either a priority, recent user or first in first out basis.

The information relating to a certain call may be cycled in time around the different broadcast bursts.

The present invention provides a repeater and a method for efficiently managing communications resources particularly direct mode communications resources where there is no central management.

Claims

1. A repeater for a direct mode communication between a first transmitter and a first receiver, the repeater comprising:
5 a signalling scheme for providing non-call related information.
2. The repeater of claim 1 wherein the non-call related information includes a message structure indicating whether the information is repeater non-call related information in traffic.
10
3. The repeater of claim 1 wherein the non-call related information includes a message structure indicating whether the information is repeater non-call related information in idle mode.
- 15 4. The repeater of any of the preceding claims wherein the information includes any of the following alone or in combination: current user or group on repeater channel if in traffic, priority in use, time in use, last user or group, priority or time since use if idle.
- 20 5. A method for a providing non-call related information by a repeater for a direct mode communication, the method comprising the steps of:
 recording non-call related information by the repeater about direct mode communications involving the repeater;
 summarising the non-call related information about the
25 communications; and
 periodically transmitting the summarised non-call related information.
- 30 6. The method of claim 5 wherein the non-call related information is a call request.
7. A repeater and a method of operation therefor substantially as herein described with reference to the drawings.



Application No: GB 9609710.0
Claims searched: 1 to 7

Examiner: Mr Jared Stokes
Date of search: 24 June 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H4L (LDRR, LDRSF, LDRSX, LDSL)

Int Cl (Ed.6): H04B (7/14, 7/145, 7/15, 7/155, 7/204, 7/26)

Other: On-Line: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB 2 260 467 A (Blick) See page 4 paragraph 1	1,2,4
X	EP 0 145 983 A2 (Fujitsu) See page 3 lines 6-22	1
X	WO 95/24655 A2 (Nokia) See page 5 line 28-page 6 line 12, page 8 lines 14-28, page 10 line 17-page 12 line 19	1,4,5,

X Document indicating lack of novelty or inventive step
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