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**H04Q 7/38**

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**H4L** LDSU L1H10

(56) Documents Cited
**EP 0629056 A1**

(58) Field of Search
UK CL (Edition O) **H4L LDB LDSE LDSJ**
INT CL[6] **H04B 7/26, H04Q 7/30 7/32 7/36 7/38**
**On-Line - WPI**

(54) Abstract Title
**Allocating traffic channels in a TDMA system**

(57) A TDMA communications system has a main carrier and at least one secondary carrier, each carrier having timeslots which may be used as traffic channels. The first timeslot of the main carrier is reserved for the main control channel whilst the other timeslots are, when traffic loading allows, reserved for synchronisation words (SYNC) and system information (SYSINFO), thereby enabling, for example, mobile phones to quickly synchronise with base stations. In an attempt to keep the main carrier timeslots free, channels are allocated to the carriers according to a predefined sequence, whereby an attempt is first made to put traffic onto the secondary carriers, the main carrier only being used if this attempt fails. Also mentions "freeing-up" the main carrier's traffic carrying timeslots, when timeslots become available on the secondary carriers, by reallocating them to the secondary carriers.

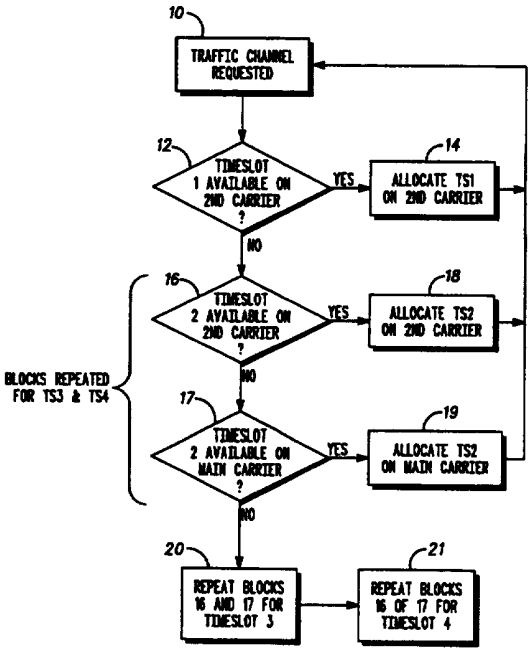


*FIG.1*

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

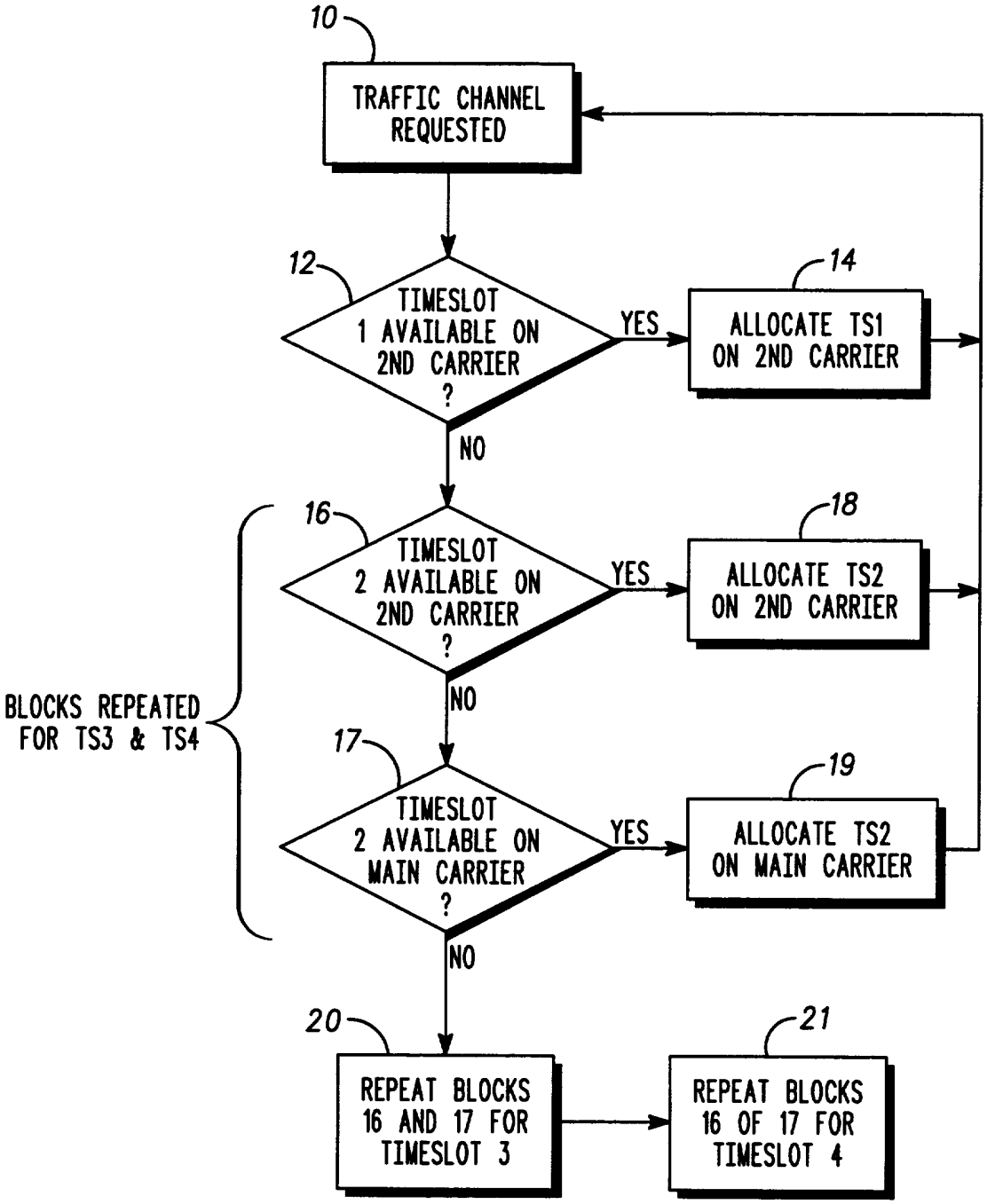
10
TRAFFIC CHANNEL REQUESTED
12
TIMESLOT 1 AVAILABLE ON 2ND CARRIER ?
YES
14
ALLOCATE TS1 ON 2ND CARRIER
NO
16
TIMESLOT 2 AVAILABLE ON 2ND CARRIER ?
YES
18
ALLOCATE TS2 ON 2ND CARRIER
NO
BLOCKS REPEATED FOR TS3 & TS4
17
TIMESLOT 2 AVAILABLE ON MAIN CARRIER ?
YES
19
ALLOCATE TS2 ON MAIN CARRIER
NO
20
REPEAT BLOCKS 16 AND 17 FOR TIMESLOT 3
21
REPEAT BLOCKS 16 OF 17 FOR TIMESLOT 4

FIG. 1

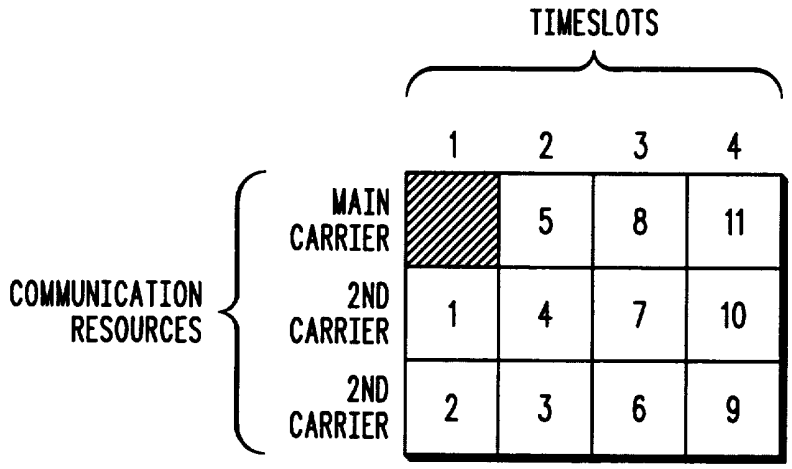
TIMESLOTS
1
2
3
4
COMMUNICATION RESOURCES
MAIN CARRIER
2ND CARRIER
2ND CARRIER
5
8
11
1
4
7
10
2
3
6
9

FIG. 2

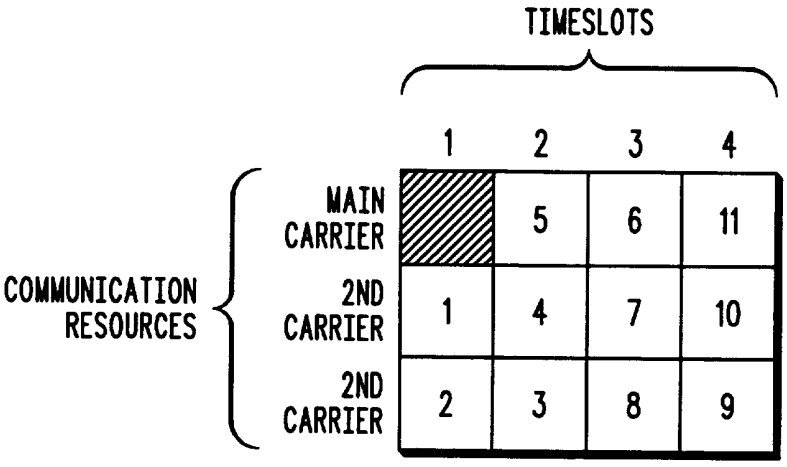
TIMESLOTS
1
2
3
4
COMMUNICATION RESOURCES
MAIN CARRIER
2ND CARRIER
2ND CARRIER
5
6
11
1
4
7
10
2
3
8
9

FIG. 3

# METHOD FOR ALLOCATING A TRAFFIC CHANNEL IN A COMMUNICATIONS SYSTEM

## Field of the Invention

This invention relates in general to a method for allocating a traffic channel in a TDMA communications system, and more particularly to a method of allocating a traffic channel by a predetermined scheme so that at least one timeslot on a main carrier is free.

## Background to the Invention

Trunked radio systems require synchronisation and system information be communicated before a mobile station is allocated a communications resource to communicate over or access to the services of the system.

In a TDM system, communication resources are divided into frames that are further sub divided into time slots. A particular communication resource may be a time slot on a particular radio frequency or channel.

Trunked radio systems generally use a slotted control channel for signalling between mobile stations and the fixed infrastructure. Each slot on the control channel generally has a synchronisation sequence which a mobile searches for when it is first powered on. Once the mobile is synchronised, it can send signalling to and receive signalling from the infrastructure giving it access to the services of the system.

Many communications systems also periodically send system information on the control channel which a mobile needs to receive before it can obtain access to the services of the system. On some systems, there is also an extended synchronisation sequence which is sent periodically and not necessarily in every slot. This allows the synchronisation sequence in each slot to be shortened and more bits in the slot allocated for signalling or voice/data. On such systems, the mobile needs to acquire the extended synchronisation sequence before it can access the system.

The time which the mobile takes to acquire synchronisation and system information is determined by the periodicity of sending of this information. However, the system also needs to allocate as much capacity as possible for signalling information and voice/data traffic which limits the capacity available for overhead signalling such as synchronisation and system broadcast information.

For example, in the ETSI standard Trans European Trunked RAdio systems (TETRA) SYNC contains the extended synchronisation sequence and system information and is sent approximately once per second. SYSINFO contains more system information and is also sent once per second meaning that the mobile usually takes at least 2 seconds to acquire the necessary information needed to access the system.

When a mobile powers on, it uses a stored list of possible main carriers to look for a carrier with sufficient signal strength to acquire and provide system services. Once, the mobile has acquired found a carrier it can use, it attempts to synchronise with the extended synchronisation sequence and then decode the SYNC and SYSINFO system information.

If all of the slots on the main carrier are being used for traffic channels when a mobile powers up, the only SYNC and SYSINFO transmissions on the main carrier in a communications system such as TETRA will be in frame 18. If all of the slots on the main carrier are being used for traffic channels acquisition time is extended for the mobile as frame 18 only comes around once per second. Furthermore, there are times when SYSINFO comes after SYNC in frame 18 and SYNC must be decoded before the mobile can look for SYSINFO. Therefore, it can be up to 2 seconds before SYNC and SYSINFO are acquired. Furthermore, if the mobile fails to acquire SYNC in frame 18, it must wait for a second before another extended synchronisation sequence comes around meaning that the acquisition time could be several seconds. Several seconds is too long for a public safety system where the user expects to turn on the radio and immediately be able to access the system.

Thus, there is a need to provide an increased regularity of sending the synchronisation and system information to ensure fast acquisition time for mobiles at power-on.

## Summary of the Invention

According to the present invention, a method is provided for allocating a traffic channel in a TDMA communications system having a main carrier and at least one secondary carrier where the main carrier and the at least one secondary carrier have timeslots that may be available for use as traffic channels, the method comprising the step of allocating by a predetermined

scheme a timeslot for use as a traffic channel so that at least one timeslot on the main carrier is free.

Brief Description of the Drawing

FIG. 1 shows a flow chart according to an embodiment of the present invention.

FIGs. 2 and 3 show a main and secondary communications carriers divided into timeslots.

Detailed Description of the Preferred Embodiment

This invention is described with reference to a communications system which has a number of carriers at each base station site with each carrier divided into four time slots. One of the carriers (called the main carrier) has time slot 1 as the main control channel with the remaining slots being available for use as traffic channels. When a slot is not allocated as a traffic channel, it can carry extended synchronisation sequences (SYNC) and more system information (SYSINFO) information to allow mobiles to acquire the system.

Note, however, a channel allocation strategy in use at the base station, may have a second carrier for carrying SYNC and SYSINFO information in a free slot which the mobile is trying to acquire.

The present invention proposes a channel allocation strategy which makes sure that the traffic channels are allocated on carriers other than the main carrier so that the idle slots on the main carrier can be filled with SYNC and SYSINFO information in every frame. This minimises the time the mobile needs to wait for SYNC and SYSINFO. Only if all slots on secondary carriers are full, then traffic channels are allocated on the main carrier. However, if there are slots allocated on the main carrier and a slot becomes available on another carrier because the call has ended, then the call on the main carrier may be moved to the other carrier.

FIG. 1 shows a method of allocating a traffic channel in a TDMA communications system having a main communications carrier and at least one secondary communications carrier. The main carrier and the at least one secondary carrier are divided into timeslots. The timeslots may be available for use as traffic channels. The communications system allocates, by a predetermined scheme, timeslots for use as a traffic channel so that at least one timeslot on the main carrier is free. When a traffic channel is

requested by a mobile station, as in step 10 of FIG. 1, the predetermined scheme checks timeslot 1 on the secondary carrier (or secondary carriers) and if timeslot 1 is available, then timeslot 1 on the secondary carrier is allocated as a traffic channel per the traffic channel request, step 14. If timeslot 1 is not available on the secondary channel(s), as determined in step 12, then it is determined whether timeslot 2 on the secondary carrier (or carriers) is available as in step 16. If timeslot 2 is available then timeslot 2 is allocated as in step 18. If timeslot 2 is not available, as determined in step 16, then it is determined whether timeslot 2 on the main carrier is available, step 17. If timeslot 2 is available on the main carrier then it is allocated as a traffic channel as in step 19. The process of steps 16-19 are repeated for timeslot 3, step 20 and timeslot 4, step 21. By the way of example, FIG. 1 shows reference to one secondary carrier, but it is entirely within the scope of the present invention to cover a similar method having a plurality of secondary carriers.

Thus, all of the traffic channels of the secondary carriers may be allocated before the channels of the main carrier are allocated. The method of the present invention allows for allocating a timeslot for use as a traffic channel so that at least one timeslot on the main carrier is free. The method of the present invention further allows for allocating a timeslot for use as a traffic channel so that at least one timeslot on the at least one secondary carrier is free. Some advantages of the present invention are that the system may broadcast synchronisation and system information on the timeslot(s) left free, or it may allocate the free timeslot(s) in combination with another timeslot already allocated on the carrier for the purposes of providing simultaneous voice and data services to the mobile station(s) using the timeslot. Alternatively, the system may allocate the free timeslot(s) in combination with another timeslot already allocated on the carrier for the purposes of expanding the data capacity of an allocated channel. By maximising the chance of there being a free timeslot on all carriers, this maximises the opportunity to allocate additional slots for simultaneous voice and data or bandwidth on demand.

Furthermore, the system may also recognise (for example, using mobile capability information transmitted to the system at registration) which mobile stations are capable of multi-slot operation (and so can take advantage of simultaneous voice and data or bandwidth on demand services) and use this information to allocate channels for multi-slot capable mobile stations on carriers where one or more slots will kept free for as long as

possible. Therefore, the channel allocation algorithm will tend to allocate channels for single-slot capable mobile stations on the same carrier(s) and allocate the final slot on those carriers before allocating the final slot on a carrier where there are multi-slot capable mobile stations. This strategy maximises the probability of there being a free slot for multi-slot capable mobile stations to request or be given additional bandwidth during the call.

FIG. 2 shows an allocation scheme according to an embodiment of the present invention. The timeslots are numbered in ordered of their allocation as traffic channels according to the present invention. Thus, the predetermined scheme allocates a first timeslot for use as a traffic channel on the secondary carrier, shown as 1 in the first timeslot of the first secondary channel. Note, if there are more secondary channels the scheme allocates all the first timeslots in the secondary carriers (as shown in FIG. 2). Then the second timeslots on the secondary carriers are allocated before the second timeslot on the main carrier is allocated, shown by numbers 3-5 in FIG. 2. The third timeslots on the secondary carriers are allocated as traffic channels before the third timeslot on the main carrier is allocated, numbers 6-8 in FIG. 2. Similarly, the fourth timeslots on the secondary carriers are allocated before the fourth timeslot on the main carrier is allocated, numbers 9-11 in FIG. 2.

A variation of a scheme according to a further embodiment of the present invention is shown in FIG. 3. The method allocates a first timeslot on the secondary carriers, then a second timeslot on the secondary carriers before allocating a second timeslot on the main carrier (numbers 1-5, FIG. 3) Then the method allocates a third timeslot on the main carrier, before allocating third and fourth timeslot on the secondary carriers (numbers 6-10). However, the last timeslot allocated is the last available timeslot on the main carrier (number 11, FIG. 3). Thus, a timeslot is still left free on the main carrier, unless the system is completely full.

A further advantage of the present invention is that only when all traffic channels on the system are allocated is there no regular SYNC/SYSINFO on the main carrier. In such a case, however, the system is loaded anyway and the requirement to acquire the system quickly is less important; if the mobile requests to talk, it is going to be queued anyway. Furthermore, the situation with all channels allocated is not very likely in most systems and it certainly does not persist for a long time. The present invention allows for as soon as a channel becomes available on any carrier, the base station may or will move calls

from the main carrier to free up slots and ensure frequent sending of SYNC/SYSINFO.

Thus, the present invention provides a system channel allocation strategy which enhances the operation of a communications system by guaranteeing fast acquisition of synchronisation and system information needed by a mobile to access the system. The present invention ensures that the mobile is able to access a system with 100 msec of the user turning on the radio which is an important requirement for public safety users. The present invention also maximises the possibility of traffic channel allocation for simultaneous voice and data as well as of channel capacity for bandwidth on demand expansion.

Claims

1. A method of allocating a traffic channel in a TDMA communications system having a main carrier and at least one secondary carrier where the main carrier and the at least one secondary carrier have timeslots that may be available for use as a traffic channel, the method comprising the step of:

allocating by a predetermined scheme a timeslot for use as a traffic channel so that at least one timeslot on the main carrier is free.

2. The method of claim 1 further comprising the step of:

allocating by a predetermined scheme a timeslot for use as a traffic channel so that at least one timeslot on the at least one secondary carrier is free.

3. The method of any of the preceding claims further comprising the step of:

broadcasting synchronisation and system information on the timeslot left free.

4. The method of any of the preceding claims further comprising the step of:

allocating the free timeslot for voice or data in combination with an already allocated voice or data timeslot to allow simultaneous voice and/or data transmission on two timeslots.

5. The method of any of the preceding claims further comprising the step of:

allocating the free timeslot for data in combination with an already allocated timeslot in order to expand data capacity of an already allocated timeslot.

6. The method of any of the preceding claims wherein the predetermined scheme comprises the steps of:

allocating a first timeslot for use as a traffic channel on the secondary carrier;

allocating a second timeslot for use as a traffic channel on the secondary carrier;

allocating a second timeslot for use as a traffic channel on the main carrier;

allocating a third timeslot for use as a traffic channel on the secondary carrier;

allocating a third timeslot for use as a traffic channel on the main carrier;

allocating a fourth timeslot for use as a traffic channel on the secondary carrier;

allocating a fourth timeslot for use as a traffic channel on the main carrier.

7. The method of claim 6 wherein there are a plurality of secondary channels and the step of allocating a first timeslot for use as a traffic channel on the secondary channel includes allocating a first timeslot for use on all the plurality of secondary channels.

8. The method of claim 7 wherein the step of allocating a second timeslot for use as a traffic channel on the secondary channel includes allocating a second timeslot for use on all the plurality of secondary channels.

9. The method of claim 8 wherein the step of allocating a third timeslot for use as a traffic channel on the secondary channel includes allocating a third timeslot for use on all the plurality of secondary channels.

10. The method of claim 6 wherein there are a plurality of secondary channels and the step of allocating a fourth timeslot for use as a traffic channel on the secondary channel includes allocating a fourth timeslot for use on all the plurality of secondary channels.

11. The method of claim 1 wherein the predetermined scheme comprises:

allocating single-slot capable mobile stations on a first secondary carrier;

allocating multi-slot capable mobile stations on a second secondary carrier; and

allocating a final timeslot on the first secondary carrier before allocating a final timeslot on the second secondary channel.

12. A method of allocating a traffic channel in a TDMA system substantially as herein described with reference to FIG. 2 of the drawing.

The Patent Office

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| | | | |
|---|---|---|---|
| **Application No:** | GB 9702493.9 | **Examiner:** | Mr Jared Stokes |
| **Claims searched:** | 1 to 12 | **Date of search:** | 27 March 1997 |

## 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 (LDSE, LDJ, LDB)

Int Cl (Ed.6): H04B (7/26)
H04Q (7/30, 7/32, 7/36, 7/38)

Other: On-Line - WPI

**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | Relevant to claims |
|---|---|---|
| A | EP 0 629 056 A1 (Alcatel) 09.06.93 (see figs 3 & 4, and also WPI Abstract Accession No.95-016011/03 | - |

| | | | |
|---|---|---|---|
| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art. |
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| & | Member of the same patent family | E | Patent document published on or after, but with priority date earlier than, the filing date of this application. |