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GB 2399991 A
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GB 2236606 A
EP 1311088 A1
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(54) Abstract Title: **Dynamic allocation of random access time slots in a mobile communication system**

(57) A processor (108) for use in a fixed infrastructure (101) of a communication system (100) (eg TETRA) including also a plurality of mobile stations (109, 110) each operable to request on a control channel by a random access procedure access to a shared communication resource (PDCH) of the system, the processor being operable to adjust dynamically, according to a detected demand as measured by a number of collisions occurring in a given period of time, a number of random access opportunities (i.e time slots) available to the mobile stations to make requests for access to the shared resource by the random access procedure.

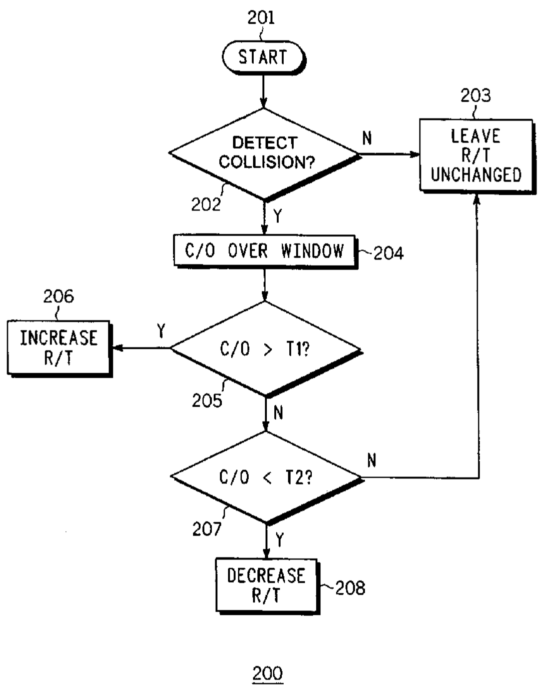

FIG. 2

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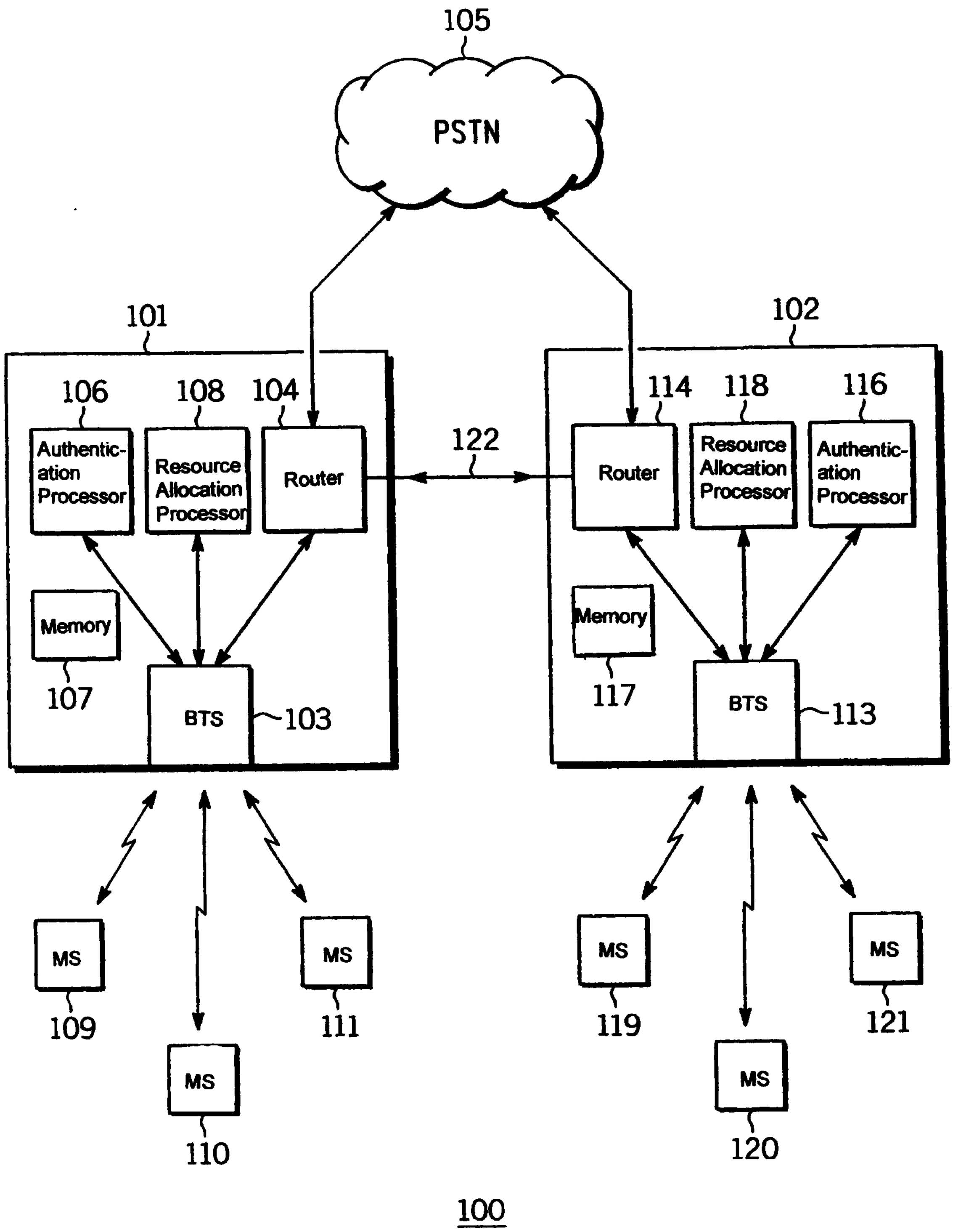
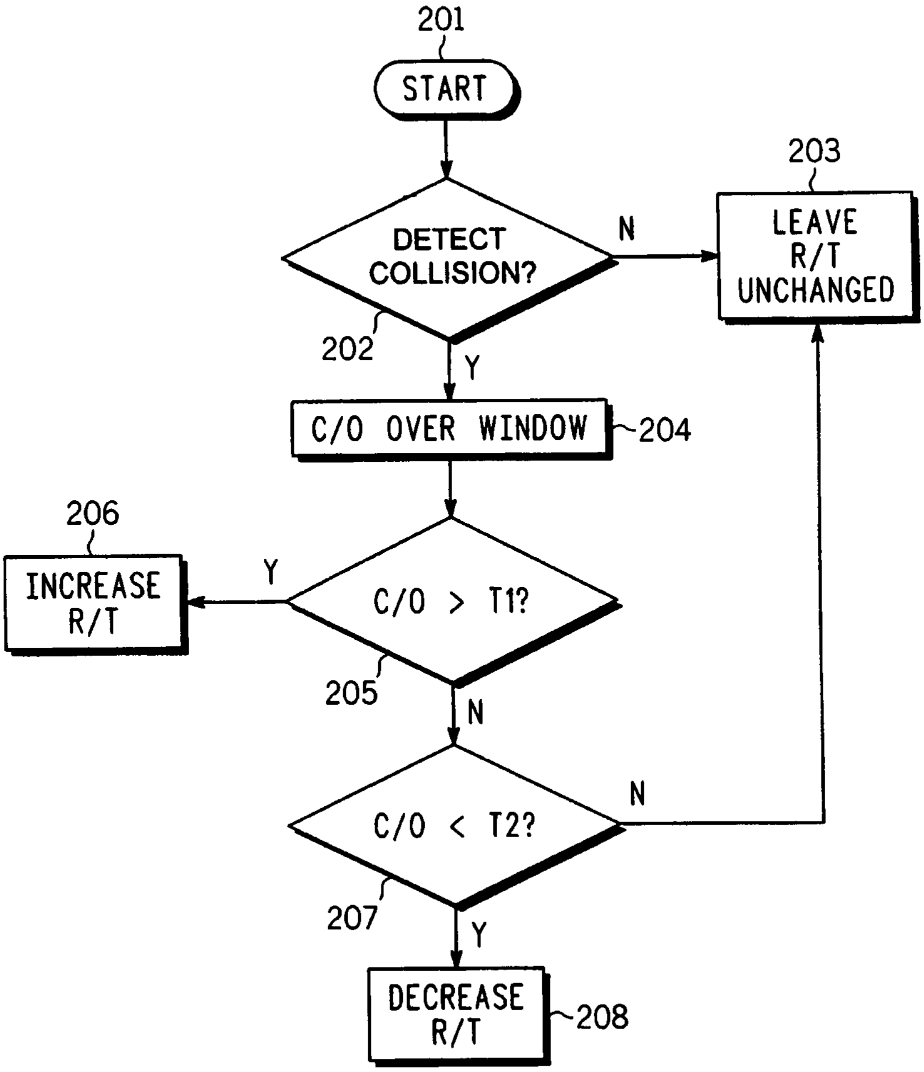

105
PSTN
101
102
106
108
104
114
118
116
Authentic-ation Processor
Resource Allocation Processor
Router
122
Router
Resource Allocation Processor
Authentic-ation Processor
Memory
107
BTS
103
Memory
117
BTS
113
MS
109
MS
110
MS
111
MS
119
MS
120
MS
121
100

FIG. 1


201
START
DETECT COLLISION?
202
N
203
LEAVE R/T UNCHANGED
Y
C/O OVER WINDOW
204
206
INCREASE R/T
Y
C/O > T1?
205
N
C/O < T2?
N
207
Y
DECREASE R/T
208

200

FIG. 2

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TITLE: COMMUNICATION SYSTEM AND A PROCESSOR AND A METHOD FOR USE THEREIN

FIELD OF THE INVENTION

The present invention relates to a communication system and a processor and a method for use therein. In particular, it relates to a mobile communication system having a processor which allocates wireless communication resources to mobile stations.

BACKGROUND OF THE INVENTION

Mobile wireless communication systems, for example cellular telephony or private mobile radio communication systems, typically provide for radio telecommunication links to be arranged between a plurality of user or subscriber terminals, often termed 'mobile stations', MSs, via a system infrastructure including one or more base transceiver stations (BTSs). Methods for communicating information simultaneously in such systems exist wherein communication resources are shared by a number of users. Such methods are termed 'multiple access' techniques. A number of multiple access techniques exist, whereby a finite communication resource is divided into a number of physical parameters.

Within such multiple access techniques, different duplex (two-way communication) paths are arranged. Such paths can be arranged in a frequency division duplex (FDD) configuration, whereby a frequency is dedicated for uplink communication, i.e. from a MS to its serving BTS, and a second frequency is dedicated for downlink communication, i.e. from a serving BTS to one or more MSs. Alternatively, the paths can be arranged in a time division duplex (TDD) configuration, whereby a first time period is dedicated for up-link communication and a second time period is dedicated for downlink communication.

An example of a mobile wireless communication system is a TETRA (TErrestrial Trunked Radio) system, which is a system operating according to TETRA standards or protocols as defined by the European Telecommunications Standards Institute (ETSI). A primary focus for a TETRA system is use by the emergency services, as TETRA provides efficient dispatch and control services. The system infrastructure in a TETRA system is generally referred to as a switching and management infrastructure (SwMI), which contains substantially all of the communication elements apart from the MSs.

The communication system may provide radio communications between the infrastructure and MSs (or between MSs via the infrastructure) of information in any of the known forms in which such communications are possible. In particular, information may represent speech, sound, data, picture or video information. Data information is usually digital information representing written words, numbers etc, i.e. the type of user information processed in a personal computer, often referred to in relation to communication in a network as 'text' information or 'packet data' information. In addition, control signalling messages are communicated. These are messages relating to the communication system itself, e.g. to control the manner in which user information is communicated in compliance with the selected industry protocol such as TETRA. Different channels may be used for communication of the different forms of information. In particular, control channels are used for transmission of control signals and packet data channels, PDCH, are used to provide packet data services, PDS, in which packet data information is sent to or from MSs.

In TETRA systems and in some other trunked or cellular systems, when a user needs to make a new request to access to a particular resource of the system, for example to access a particular channel, e.g. a PDCH, this request is made using a method known as a 'random access' procedure. The method is also known as 'Reservation ALOHA'. In this procedure, the user's MS sends a request message on a control channel to a processor of the infrastructure, known as the BRC or 'Base Radio Controller', indicating the resource required, e.g. capacity in a particular communication channel such as a PDCH, to which access is required. The request may be successful or unsuccessful depending on whether it is chosen or not by the random access procedure. If it is successful, the BRC may grant the request in whole or in part by reserving all or some of the capacity requested.

TETRA systems use TDMA (time divided multiple access) operating protocols in which communications are synchronised to be in a continuous timing structure which consists of time slots, frames and multiframes. Four slots make up a frame and eighteen frames make up a multiframe (one second). In such a protocol, some designated slots in the timing procedure of the control channel may be reserved for channel access communications. The infrastructure informs the MSs of users through its downlink transmission that certain forthcoming slots, say the next say N slots, are to be devoted to the random access procedure. These slots are available for the MSs which require access to a system resource to have opportunities to request the infrastructure to allow or reserve access to the resource. A MS will use a random access opportunity in one of the designated slots to make a random access request. If the request is successful, the infrastructure will reserve or grant access to the appropriate resource to the MS as described earlier. The resource when granted may be defined in terms of a number of identified slots made available, e.g. on a PDCH.

These random access opportunities are available to all legitimate MSs operating within a given cell. This may include, for example, all MSs within the cell or all MSs in a given user class within the cell as specified by the infrastructure. Collisions may occur in the sending of requests. When this happens, each MS concerned will not receive any feedback from the infrastructure as to the success of its request and may need to try, after some delay, to repeat the request procedure. Collisions are therefore an undesirable consequence of the random access procedure.

TETRA systems also operate a procedure for access to a resource such as a PDCH which is known as 'reserved access'. In this procedure, resource capacity is allocated to MSs which are already taking part or which have already taken part in a communication using the requested resource or have requested the BRC to reserve further resource capacity. Such allocations may need to be made for the following reason. A packet data or short data packet normally needs to be divided into several smaller parts, so that each part may be contained in an allocated slot of the timing structure on the air interface. Since a package of data may be greater in size than a slot or number of adjacent slots, further parts of the package may need to be sent in later slots which need to be reserved by the BRC.

In known TETRA systems, a proportion of the control channel resources available for channel access signals are guaranteed for the reserved access procedure and the requests made by the reserved access procedure may be given priority over requests made by the random access procedure.

In currently available TETRA systems, control channels are configurable, i.e. the positions of slots for use in making requests by the random access procedure can be selected by the system infrastructure, specifically the BRC, but it is usual to employ a constant amount of the control channel resources per unit time, e.g. a constant number of slots per multiframe, for opportunities for signals relating to access to the PDCH, and of those opportunities a fixed maximum number are guaranteed for random access purposes, the rest are used for reserved access signals. The resources for reserved access may be used as random access opportunities if there are no current reserved access requests.

The present inventors have recognised that there is a problem with the currently available system in that control channel traffic patterns (i.e. the number of mobile stations attempting to use the control channels) cannot be foreseen and therefore it is difficult or even impossible for a system designer to configure the control channels so that there is always an appropriate amount of control channel resource available for random access, and at the same time the control channel resources are efficiently utilised to deal with reserved access.

This problem is prevalent particularly when a control channel is heavily loaded, because if the channel is configured in favour of random access but more resources should have been available for reserved access, part of the channel resources will be wasted. Alternatively, if the channel is configured in favour of reserved access but more resources should have been available for random access, the channel might operate inefficiently because a few mobile stations which are heavy resource users (with a large reservation requirement) might block other users from accessing the control channel. In particular, if available control channel resources for random access are limited while there are many random access attempts, collisions will make it very difficult for the MSs to gain access to the BRC via random access. Furthermore, as noted earlier, the currently available procedure tends to favour those resource reservation requests made via reserved access. Thus, if one or more MSs have large amounts of data to send, they will need to make repeated requests for more resources - via reserved access. Therefore, the BRC tends to grant resources to such heavy users first.

SUMMARY OF THE INVENTION

According to the present invention in a first aspect there is provided a processor for use in an infrastructure of a communication system, the processor being as defined in claim 1 of the accompanying claims.

According to the present invention in a second aspect there is provided a communication system, the system being as defined in claim 16 of the accompanying claims.

According to the present invention in a third aspect there is provided a method of operation in a communication system, the method being as defined in claim 18 of the accompanying claims.

The processor of the invention, which may for example comprise a Base Radio Controller, BRC, operates in an infrastructure to adjust dynamically the resources available on one or more control channels for mobile stations to make random access requests. The processor may also allocate access to a shared resource, e.g. a PDCH, of successful random access requests it receives via the one or more control channels. The dynamic adjustment of the resources available on one or more control channels is done according to demand.

Preferably, the processor determines the demand by calculating the number of collisions of random access attempts that have taken place in a given time period ('window') on a given control channel, e.g. as a total number of opportunities, e.g. slots made available for access request signals, in the given period. The processor then makes decisions as to whether to raise, reduce or leave unchanged the number of opportunities for random access requests for a given period on the control channel.

Beneficially, the invention allows traffic patterns on a control channel to be monitored and allows the number of random access opportunities to be dynamically adjusted, preferably as a fraction of the total number of opportunities available (including reserved access opportunities), based on the monitored traffic loading, to minimise undesirable collisions between random access requests and to maintain efficient use of the control channel.

Embodiments of the present invention will now be described by way of example with reference to the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block schematic diagram of a mobile communication system embodying the present invention.

FIG. 2 is a flowsheet of a procedure operated by an infrastructure processor in the system illustrated in FIG. 1.

DESCRIPTION OF EMBODIMENTS OF THE INVENTION

FIG. 1 shows a communication system 100 operating in accordance with an embodiment of the invention. The system 100 may be a TETRA system. The system 100 includes a first network infrastructure 101 and a second network infrastructure 102. The network infrastructure 101 includes as known main components (together with other components) (i) a BTS (base transceiver station) 103 which includes one or more transceivers providing radio communication with mobile stations within range of the BTS 103; (ii) a router 104 for routing communications into and out of the network infrastructure 101, e.g. via a PSTN (public switched telephone network) 105, and within the network infrastructure 101 and to the mobile stations served thereby; (iii) an authentication processor 106 which carries out authentication functions of the network infrastructure 101 and a memory 107 which stores data and programs needed in operation by processors of the network infrastructure 101. The network infrastructure 101 also includes a resource allocation processor 108, e.g. a Base Radio Controller, which controls allocation of communication resources available to mobile stations served by the network infrastructure 101.

The system 100 also includes a plurality of MSs (mobile stations) served by the network infrastructure 101, particularly by the BTS 103, three of which, MSs 109, 110 and 111 are shown.

The network infrastructure 102 includes as known main components (together with other components) (i) a BTS (base transceiver station) 113 which includes one or more transceivers providing radio communication with mobile stations within range of the BTS 113; (ii) a router 114 for routing communications into and out of the network infrastructure 102, e.g. via a PSTN (public switched telephone network) 105, and within the network infrastructure 102 and to the mobile stations served thereby; (iii) an authentication processor 116 which carries out authentication functions of the network infrastructure 102 and a memory 117 which stores data and programs needed in operation by processors of the network infrastructure 102. The network infrastructure 101 also includes a resource allocation processor 118 which controls allocation of communication resources available to mobile stations served by the network infrastructure 102.

The system also includes a plurality of MSs (mobile stations) served by the network infrastructure 102, particularly the BTS 113, three of which, MSs 119, 120 and 121 are shown.

A link 122 exists between the network infrastructure 101 and the network infrastructure 102. The link 122 may be formed in one of the ways known in the prior art. The link 122 may for example be provided by radio or microwave communication, hard wired electrical or optical communication, or the internet.

If, say, the MS 109 is to communicate with another mobile station the MS 109 first registers with the network infrastructure 101 by a known procedure which includes sending radio messages between the MS 109 and the BTS 103 and the messages being passed between the BTS 103 and the authentication processor 108. The authentication processor 108 verifies that the MS is to be served by the network infrastructure 101. When registration has been established, a communication set up request radio signal is received from the MS 109 at the BTS 103 and is passed to the resource allocation processor 108. The processor 108 allocates a resource for a communication in a manner to be described later. When the resource is available, the router 104 routes the communication appropriately. For example, if the communication is to be directed to the MS 119, the router 104 routes the communication via the link 122 via the network infrastructure 102, particularly the router 114 and the BTS 113. Alternatively, if the communication is to be sent to another terminal (not shown) in a remote location the router 104 may route this via the PSTN 105.

Operation of the resource allocation processor 108 will now be described in more detail. The resource allocation processor 118 operates in a similar manner. The operation is described in terms of (i) adjustment of resources made available on a control channel for random access requests; and (ii) allocation of access to a packet data channel (PDCH); in compliance with the TETRA standard. This is for illustration purposes only. Operation is not necessarily limited to this particular form of operation. The packet data channel is used for communication to and from mobile stations of packet data, i.e. packets of data comprising text information, e.g. alphanumeric characters etc, or possibly picture information, e.g. entered by a user at a user terminal using a keyboard or the like.

The user of each mobile station served by the network infrastructure 101 wishing to send a packet data communication initially requests packet data services (e.g. by selection from a menu displayed on a display of the mobile station) and is thereby connected via the BTS 103 to the resource allocation processor 108. Next, the mobile stations are notified by the resource allocation processor 108 of forthcoming random access opportunities it has allocated for making requests via a control channel to have access to a data channel. These requests may be defined slots in the TETRA TDMA timing structure as referred to earlier of the control channel. Next, a resource reservation request is made to send a packet data communication. The request is sent from the mobile station, say MS 109, to the BTS 103 via a control channel (e.g. the MCCH) in one of the defined slots and, if successful, is passed by the BTS 103 to the processor 108. The request includes an indication of the size (length of time) of the data package to be sent. In practice, the request is sent in a resource request data message ('PDU') in which there is a field indicating how many slots are required. The layer 2 addressing software of the mobile station automatically calculates this size. The processor 108 receives a number of resource reservation requests on an ongoing basis. Some of the requests received are made by the reserved access procedure referred to earlier and some are made by the random access procedure referred to earlier.

In accordance with an embodiment of the invention, the processor 108 monitors the demand for making such requests on the control channel by the mobile stations, i.e. it monitors the number of requests made by the random access procedure by determining whether congestion is occurring (collisions are occurring) in the making of such requests. It quantifies the extent of congestion giving an indication of demand by mobile stations for use of the control channel to make such requests and if appropriate adjusts the resource made available on the control channel (e.g. MCCH) for making such requests. A detailed procedure employed by the processor 108 is as follows.

Referring now to FIG. 2, a procedure 200 is operated by the processor 108. The procedure 200 may be run periodically, e.g. for each forthcoming window, e.g. for each forthcoming multiframe in the TETRA TDMA timing structure for which the processor 108 is about to allocate availability of resources. The procedure 200 starts when triggered, e.g. by a timer associated with the processor 108, at a step 201. At a decision block step 202 the processor 108 determines a demand for use of whether or not congestion is taking place, ie. By whether a collision has occurred. It may carry out this step by determining, using a Received Signal Strength Indicator (RSSI) associated with the BTS 103 in a known manner, whether one or more signals have arrived on the control channel in a given period of time at the BTS 103. From this number, the processor 108 can calculate if a congestion/collision has occurred. This procedure may be may be carried out as follows.

The output of an RSSI for a given channel (here the control channel) is a measure of whether a signal has been received on the channel in a given period. If the RSSI output is lower than a given threshold, it means that no signal has been received. If the RSSI output is higher than a given threshold, this indicates that a signal has been received. However, this is not necessarily a useful signal, because a RSSI high output value may mean that two or more received signals have collided in the given period. Therefore, another check may usefully be carried out, namely to find a CRC (cyclic redundancy check) status of a received signal. If the RSSI output is high and the CRC status is valid ('OK'), it means that a signal has been received and the signal is a valid signal. If the RSSI output is high and the CRC is in error, it means that a signal has been received but either a collision has happened or a transmission error has occurred. Since a collision is more likely than a transmission error, a high RSSI output and a CRC status in error in a given period for random access opportunity may be taken as a collision. Alternatively, a further procedure may be applied to ensure that the CRC status in error result has not resulted from a transmission error.

If the result of the determination at step 202 is no signal found ('N'), i.e. no collision has occurred, the output from the procedure 200 is a step 203 which is to leave a currently applied value of a ratio R/T unchanged. The ratio R/T is a ratio of random ('R') access opportunities available to a total ('T') number of opportunities available in a given window of opportunities on the control channel.

If the result of the determination at step 202 is that a received signal is found ('Y'), i.e. a collision has occurred, the output from the step 202 is a step 204 in which a value of a ratio C/O for the given window of opportunities is calculated. The ratio C/O is a ratio of a number of collisions ('C') occurring to a total number of opportunities ('O') available on the control channel in the window considered. This value of C/O is calculated on a moving window basis, and this window size need not be the same as a subsequent window for which the ratio R/T is being calculated. This calculation of the ratio C/O provides a measure of the demand by mobile stations for use of the control channel. The ratio C/O is calculated for the given window using the number of number of received collisions at the BTS 103 divided by the number of random access opportunities within the same moving window. The latter parameter is known to the resource allocation processor 108 since it set the number of opportunities.

The ratio C/O calculated in step 204 is passed to a decision block step 205. In step 204 the ratio C/O is compared with a predetermined threshold value T1 which is a measure of a high C/O value over a predetermined time period within the window considered. The window considered is moving in terms of length of time and is configurable depending on whether the required dynamic adjustment is to be fast or slow. Ten random access opportunities would be a typical value for this window size.

If the ratio C/O is greater than T1 for the pre-determined time period, an output ('Y') from the decision block step 205 is a step 206 in which the ratio R/T for the window being considered is increased. The ratio R/T is increased by a constant increment until (after a number of runs of the procedure 200) a maximum value of the ratio R/T is reached. Thus, increasing the ratio R/T increases the number of random access opportunities slots made available in a given window. In practice, the number of slots in the TETRA TDMA timing structure referred to earlier which are made available in a given window for random access opportunities is increased in this way.

If the ratio C/O is determined in step 205 not to be greater than T1 for the pre-determined time period, an output ('N') from the step 205 is a further decision block step 207. In step 207 the ratio C/O is compared with a further predetermined threshold value T2 which is a measure of a low C/O value over a predetermined time period within the window considered. If the ratio C/O is less than T2 for the pre-determined time period, an output ('Y') from the decision block step 207 is a step 208 in which the ratio R/T for the window being considered is reduced. The ratio R/T is reduced by a constant increment until (after a number of runs of the procedure 200) a minimum value of the ratio R/T is reached. Thus, reducing the ratio R/T reduces the number of random access opportunities slots made available in a given window. In practice, the number of slots in the TETRA TDMA timing structure referred to earlier which are made available for random access opportunities is reduced in this way as a fraction of the total number of access opportunities in a given window.

Finally, if the ratio C/O is not less than T2 for the pre-determined time period, an output ('N') from the decision block step 207 is the step 203 in which the ratio R/T is left unchanged.

Thus, the procedure illustrated in FIG. 2 is run repeatedly by the processor 108 at time intervals which suit the operational parameters of the system 100. The procedure may be operated each time a collision has been detected. The result of each operation of the procedure is to change the ratio R/T (if it is not already at a pre-determined maximum or minimum value) by an increment or to leave it unchanged as appropriate.

The processor 108 may allocate resources, e.g. capacity on the PDCH, for the successful requests it receives.

Modified random access procedures may be applied, e.g. in which the number of random access attempts possible is given a weighting according to a location of the requesting mobile station. An example of such a modified random access procedure is described in Applicants' WO-A-2004/086797.

Furthermore, the resource allocation processor 108 may allocate access to the requested resource, e.g. packet data channel, on a prioritised basis in the manner described in Applicants' copending GB patent application GB0505492.9. For example, the priority may be determined according to a length of a proposed communication, e.g. data package size, to be sent on the requested resource, and/or according to the procedure by which the request is made, e.g. random access or reserved access.

CLAIMS

1. A processor for use in a fixed infrastructure of a communication system including also a plurality of mobile stations each operable to request on a control channel by a random access procedure access to a shared communication resource of the system, the processor being operable to adjust dynamically, according to a detected demand, a number of random access opportunities available to the mobile stations to make requests for access to the shared resource by the random access procedure.

2. A processor according to claim 1 wherein the processor is also operable to allocate access of mobile stations to the shared resource.

3. A processor according to claim 1 or claim 2 wherein the shared resource comprises a radio communication channel.

4. A processor according to claim 3 wherein the shared resource comprises a packet data communication channel.

5. A processor according to any one of the preceding claims wherein the processor is operable to adjust a ratio of a number of random access opportunities which will be available to a total number of opportunities available on a control channel which will be available in a given period of time for mobile stations to make requests for access to the shared resource.

6. A processor according to claim 5 wherein the total number of opportunities available in a given period of time consist of random access opportunities and reserved access opportunities.

7. A processor according to any one of the preceding claims which is operable to determine whether a level of collisions of attempts made on the control channel by mobile stations using random access opportunities to request access to the shared resource is greater than a pre-determined level and, if it is, to increase the number of random access opportunities made available.

8. A processor according to any one of the preceding claims which is operable to determine whether a level of collisions of attempts made on the control channel by mobile stations using random access opportunities to request access to the shared resource is less than a pre-determined level and, if it is, to reduce the number of random access opportunities made available.

9. A processor according to any one of the preceding claims which is operable to determine whether a level of collisions of attempts made on the control channel by mobile stations using random access opportunities to request access to the shared resource is greater than a first pre-determined level and, if it is, to increase the number of random access opportunities made available and, if it is not, to determine whether a level of collisions of attempts made on the control channel by mobile stations using random access opportunities to request access to the shared resource is less than a second pre-determined level lower than the first pre-determined level and, if it is, to reduce the number of random access opportunities made available.

10. A processor according to any one of claims 7 to 9 which is operable to determine whether the level of

collisions is greater or less than a pre-determined threshold for a pre-determined period of time.

11. A processor according to any one of the preceding claims which is operable to calculate a level of collisions by calculating a ratio of a number of collisions made to a number of random access opportunities available in a given period of time.

12. A processor according to any one of the preceding claims which is operable repeatedly to apply a procedure (i) to calculate a level of collisions of attempts made on the control channel by mobile stations using random access opportunities in a given period to request access to the shared resource; and, using the calculation result obtained, (ii) to determine whether a change needs to be made to a number of random access opportunities to be available in a given period to the mobile stations to make requests on the control channel for access to the shared resource by the random access procedure; and if needed, to make a change to the number of random access opportunities to be available.

13. A processor according to claim 12 wherein the periods of time in steps (i) and (ii) are equal.

14. A processor according to any one of the preceding claims which is operable also to prioritise requests it receives from mobile stations for access to the shared resource.

15. A processor according to claim 14 which is operable to prioritise requests it receives from mobile stations for access to the shared resource based upon (i) a procedure by which the request has been received; or

(ii) a length of communication to be made by the mobile station; or both.

16. A communication system including an infrastructure and a plurality of mobile stations wherein the infrastructure includes a processor according to any one of the preceding claims.

17. A communication system according to claim 16 which is operable in accordance with TETRA standard procedures.

18. A method of operation in a communication system including a plurality of mobile stations requesting on a control channel by a random access procedure access to a shared communication resource of the system, and a processor of a fixed infrastructure of the system adjusting dynamically, according to a detected demand, a number of opportunities available to mobile stations to make requests for access to the shared resource by the random access procedure.

19. A method according to claim 18 which includes the processor calculating a level of collisions of attempts made on the control channel by mobile stations using random access opportunities in a given period to request access to the shared resource and determining whether a change is needed to a number of random access opportunities available in a given time period based on the level calculated.

20. A method according to claim 19 or claim 20 and substantially as herein described with reference to FIG. 2 of the accompanying drawings.

21. A processor according to any one of claims 1 to 15 and operable substantially as herein with reference to

FIG. 2 of the accompanying drawings.

The Patent Office

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INVESTOR IN PEOPLE

Application No: GB0506611.3 **Examiner:** Gareth Griffiths

Claims searched: 1 & 18 **Date of search:** 18 August 2005

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-19	GB2399991 A (MOTOROLA) whole document
X	1-19	GB2347824 A (INMARSAT) abstract & p.19-22
X	1-19	EP1311088 A1 (ALCATEL) abstract & paras 46-52
X	1-19	GB2236606 A (MOTOROLA) whole document
X	1-19	WO00/70814 A1 (NOKIA) abstract & p.14 line 3 - p.22 line 29
X	1-19	EP0993212 A1 (SONY) abstract & whole document

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	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.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

H4L

Worldwide search of patent documents classified in the following areas of the IPC^{07}

H04Q

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC