Method and arrangement in a radio communication system

TECHNICAL BACKGROUND

The present invention concerns a process for a radio communication system which is arranged for packet data transmission according to a message-synchronized ALOHA protocol with reservation. The invention concerns a process for requesting access in a momentarily overloaded mobile radio system, wherein an access request received in a base station from each station in a first group of mobile stations cannot be responded to by channel reservation for the first group of mobile stations.

The invention also concerns a base station and a mobile station in a radio communication system for packet data transmission.

PRIOR ART

In the case of mobile radio communication systems for packet data transmission a base station can communicate with a plurality of mobile stations via one or a plurality of time-divided channels between the base station and the mobile stations. A time-divided channel is divided into time slots. A data burst with a number of information bits can be transmitted in each time slot. The mobile stations do not communicate continuously with the base station and a plurality of mobile stations can therefore compete for the same time-divided channel. Channels are allocated dynamically, separately from the channel requirement of the mobile stations and channel allocation is controlled by the base station.

A mobile station announces a channel requirement by sending an access request to the base station. This access request is sent in a reservation phase in the time-divided channel for transmission from the mobile stations to the base station. Different types of protocol can be used in order to control the access request and channel allocation. A conventional protocol in the case of dynamic allocation of time-divided radio channels is a message-synchronized ALOHA protocol with reservation. In the case of this protocol, each packet transmission is preceded by a reservation. A short message with a request for channel reservation is sent at random from a mobile station to a base station. According to the ALOHA reservation protocol, the result of this access request is fed back by the base station giving the mobile station access

to at least part of the time-divided channel.

Since many mobile stations may have a need of packet data transmission, collisions can occur as a result of a number of mobile stations sending access requests simultaneously. This means that, of the messages sent simultaneously, in the best case the base station can accept one message (by using the so-called "capture" effect). In the case of a collision, the sending mobile stations which do not receive channel reservation have to repeat their access requests. In order to reduce the risk of a further collision, the repeated transmission occurs after a given time interval which varies for each mobile station. It is well known that this time interval can vary randomly for each mobile station.

When all the free channel capacity in a radio communication system has been reserved for communication, overloading occurs if a further mobile station sends an access request to the base station. The latter receives the access request in itself from the mobile station but cannot comply with this request within a given predetermined time interval since there is no free channel capacity. The mobile station is then forced to repeat the access request in the same way as in the case of a collision, when the predetermined time interval has elapsed. This naturally leads to unnecessary extra channel loading, unnecessary delays in the mobile system and the risk of collisions occurring when transmissions are repeated.

US-A-5 166 929, for example, earlier disclosed a multiple-access protocol, in the case of which feedback concerning the status of an access channel is provided from the base station to the mobile stations. The mobile stations can thereby receive information concerning the result of an access request, for example, that a collision has occurred, and whether the next time slot is open for the sending of new access requests. This information makes it easier to determine when a new access request should be sent. A disadvantage of this protocol is that an overload situation is unmanageable. An access request received in the base station has to be repeated in a situation in which channels temporarily cannot be allocated in the base station owing to overloading, i.e. no channels are free.

A paper entitled "Medium Access Priority" by Motorola and presented at the standardizing meeting within ETSI STC SMG2 in Edinburgh on 7 March 1995 discusses a possible need of acceptance confirmation in the case of access requests from a mobile station to a base station. According to this paper, the mobile station is thus to be informed whether the access request has been correctly accepted in the base station. However, it is not mentioned as to how this confirmation of the access request is to be carried out.

DESCRIPTION OF THE INVENTION

The object of the present invention is to propose a process in a radio communication system for packet data transmission. The invention achieves this object by managing the access request from each station in a first group of mobile stations to a base station in a momentarily overloaded radio communication system which lacks free channel capacity for data transmission.

The object is achieved by the use of a message-synchronized ALOHA protocol with reservation. Packet data transmission is carried out via one or a plurality of time-divided channels between a base station and mobile stations. The mobile stations are arranged so as to send the access request to the base station during a reservation phase in a mobile radio system which uses this protocol. The base station is arranged so as to accept and comply with the access request from a first mobile station by sending thereto a channel reservation message comprising a channel reservation. As a result of this channel reservation, time slots for packet data transmission from the first mobile station to the base station are reserved. The base station is further arranged to accept access requests from a first group of mobile stations for which channel reservation momentarily cannot be carried out. In accordance with the process according to the invention, receipt of the access request from the first group of mobile stations is confirmed when the channel reservation cannot be carried out in the usual manner. Confirmation is sent in the form of access confirmations which are included in the same channel reservation message as said channel reservation for the first mobile station. The channel reservation message is received by each of the mobile stations in the first group. The mobile stations are actuated so that they await channel reservation without making repeated access requests. In connection with the

access confirmations, a queue of the mobile stations in the first group is arranged in the mobile radio system. Channel reservation for the mobile stations in the first group is carried out according to their position in this queue.

The invention also concerns a base station and a mobile station in a radio communication system for packet data transmission. The base station and mobile station according to the invention are arranged to implement the process according to the invention.

By means of the process according to the invention the load on an access channel to the base station can be decreased since the number of times which an access request is repeated in the system is reduced. This naturally reduces the average delay in transmission of data between a mobile station and a base station. Furthermore a shorter time interval can be predetermined before the access request is initialized again, which means shorter average access delay.

DESCRIPTION OF THE DRAWINGS

Figure 1 shows a mobile radio system with mobile stations and a base station; and

Figure 2 shows a channel reservation message from a base station to mobile stations.

PREFERRED EMBODIMENT

In the following the invention will be explained in greater detail with reference to the drawings, in which Figure 1 shows a cell 1 in a mobile radio communication system with mobile stations MS1 - MS3 and a base station BS, for example a GSM system for communication via time-multiplex channels (TDMA).

In the preferred embodiment a single communication channel Ch1 adapted for packet data transmission is used. This means that both data packets and associated control signals are transmitted via the same channel.

A mobile station MS1 initiates packet data transmission by sending an access request

to a base station BS via a data packet channel. This access request comprises identification of the transmitting mobile station, for example in the form of a random figure, possibly together with information about the desired class of service (for example, priority). The access request is dispatched randomly in order to reduce the risk of access requests from a plurality of mobile stations being sent simultaneously, but the request has to be sent within a given time interval which is reserved for this type of transmission. This time interval can, for example, consist of a time slot in a number of periodically recurring time frames. When the access request has been received and if channel capacity is available for this packet data transmission, the base station BS sends a channel reservation message 2 to the mobile station MS1. This channel reservation message includes a channel reservation whereby time slots for transmitting from the mobile station to the base station are allocated. The channel reservation further includes a reference to the access request which is accepted. The reference includes the same information which was received in the access request and a reference to the time frame or time slot in the time-divided channel Ch1 in which the access request was received. A mobile station MS1 thereby receives information as to whether the channel reservation is intended for this very mobile station. The mobile station MS1, from which the access request originates, thereby receives information that it has been allocated time slots for packet data transmission.

During the time in which the mobile station MS1 carries out packet data transmission on the reserved channel, it is important that the other mobile stations MS2, MS3 do not attempt to initiate transmission on the channel. Access requests from the mobile stations are therefore only permissible when the base station BS reports that one or a plurality of time slots are free for this purpose. The base station indicates that it is possible to send access requests by placing a flag on the channel to the mobile stations MS1 - MS3. When packet data transmission in the allocated time slots has terminated, the base station indicates that a number of time slots in the channel from the mobile stations to the base station are again open for access requests. Access requests can again be sent randomly to the base station.

During the time slots which are free between the transmission of different data packets from mobile stations to the base station, i.e. open for access requests, a

plurality of mobile stations MS1 - MS3 can send an access request to the base station BS. If transmission occurs at the same time for some of the mobile stations MS1 - MS3, a collision occurs between the transmissions. In this collision situation, the base station BS is unable to interpret the message from more than at most one of the stations in question and the transmission of the access request therefore has to be repeated.

If a plurality of mobile stations MS1 - MS3 send access requests without overlapping to a base station, the channel reservation can only be carried out for one or more of these stations. When a channel reservation is carried out for a first mobile station MS1, the other mobile stations MS2, MS3 have to await free channel capacity in spite of the fact that the access requests from these stations have been received correctly in the base station BS. In re-transmission situations access requests can also be received randomly between different transmissions included in a sequence relating to the same data packet. This depends on whether it is desired to use the gaps in such a sequence so that access requests can be received. According to the invention, in order to prevent a new wave of access enquiries from these mobile stations MS2, MS3, each access request correctly received in the base station (up to a given limit) is usually responded to. Access confirmations 4, 5 are accordingly sent to at least a number of the stations MS2, MS3 which do not immediately have a channel reservation 3 accepted. These access confirmations are included in a channel reservation message 2 comprising a channel reservation 3 to the mobile station MS1 which is allocated a channel in response to the access request. Such a channel reservation message 2 is shown in Figure 2. Since this channel reservation 3 is sent in a message 2 in a format which is common to all the control messages, for example comprising four time slots, and since given control data can be used together, a limited number of access confirmations 4, 5 can be included in the same message 2.

These access confirmations consequently do not give rise to increased channel loading.

The confirmation of correctly received access requests from a number of mobile

stations enables a queue of mobile stations awaiting their turn for packet data transmission to be arranged in the mobile radio system.

When packet data transmission is used in the GSM system a limited number of access confirmations can be included in a message with channel reservation. As concerns the reference to the time frame when the enquiry from a mobile station was received, this access confirmation is carried out in two ways. The first way is to indicate the number of the time frame (related to a given multiframe structure which is used in the system), in the same way as in the channel reservation 3, in part of the channel reservation message 2. The other way is, instead, to use a reference relating to the time frame which is given in the usual channel reservation message.

It will be appreciated that the invention is not restricted to the above-described embodiment but encompasses any embodiment which lies within the scope of protection of the following claims.

CLAIMS

1. Process for a radio communication system which is arranged for packet data transmission via at least one time-divided channel (Ch1) between a base station (BS) and mobile stations (MS1 - MS3), according to a message-synchronized ALOHA protocol with reservation, the mobile stations (MS1 - MS3) being arranged to send access requests to the base station (BS), which is arranged to receive and comply with access requests from at least a first mobile station (MS1) by sending thereto a channel reservation message (2) comprising a channel reservation (3), whereby time slots are reserved for packet data transmission between the first mobile station (MS1) and the base station (BS), and to receive access requests from a first group of mobile stations (MS2, MS3) for which channel reservation momentarily cannot be carried out, **characterized in that:**

- the reception of access requests from the first group of mobile stations (MS2, MS3) is confirmed in the form of an access confirmation (4, 5) from the base station (BS) to each of the mobile stations (MS2, MS3) included in the first group;
- these access confirmations (4, 5) are included in the channel reservation message (2) with the channel reservation (3) to the first mobile station (MS1);
- the first group in the radio communication system associated with the access confirmations are arranged in a queue, a queue position being allocated to each of the mobile stations in this group; and
- channel reservation is carried out for the mobile stations according to their queue positions.

2. Process according to Claim 1, **characterized in that:**

- the channel reservation message (2) is read by all the mobile stations from which access requests are received in the base station; and
- access confirmations (4, 5) included in this channel reservation message (2) are received in the mobile stations (MS2, MS3), whereby the latter are actuated so as to await channel reservation without making repeated access requests.

3. Process according to either of the preceding claims, **characterized in that:**

- a first reference is supplied in the channel reservation (3) to the first mobile

station, which first reference refers to a first time slot in the time-divided channel (Ch1), in which first time slot the access request from the first mobile station (MS1) was received in the base station (BS); and

- a second reference is supplied in each access confirmation (4, 5), which second reference refers to a second time slot in the time-divided channel (Ch1), in which second time slot access requests were received in the base station (BS) from the respective mobile station (MS2, MS3) for which the access confirmations are intended.

4. Process according to claim 3, **characterized in that**:

- the second reference is made up of the number of time slots between the first time slot and the second time slot.

5. Process in the case of a base station in a radio communication system which is arranged for packet data transmission, via at least one time-divided channel, between a base station and mobile stations, according to a message-synchronized ALOHA protocol with reservation, comprising the following steps:

- receiving access requests from the mobile stations;
- complying with the access request from at least a first mobile station by sending a channel reservation thereto, whereby time slots are reserved for packet data transmission between the first mobile station and the base station;
- giving access confirmations to each mobile station in a first group of mobile stations on receipt of access requests from the first group of mobile stations for which channel reservation momentarily cannot be carried out;
- sending these access confirmations in the same message as the channel reservation for the first mobile station;
- arranging, in association with the access confirmations, in the radio communication system a queue of the mobile stations in the first group, a queue position being allocated to each mobile station; and
- carrying out channel reservation for the mobile stations according to their queue positions.

6. Base station in a radio communication system, which is arranged for packet data transmission via at least one time-divided channel (Ch1) between the base

station (BS) and mobile stations (MS1 - MS3), according to a message-synchronized ALOHA protocol with reservation, the mobile stations (MS1 - MS3) being arranged to send access requests to the base station (BS), which is arranged to receive and comply with access requests from at least a first mobile station (MS1) by sending thereto a channel reservation message (2) comprising a channel reservation (3), whereby a number of time slots are reserved for packet data transmission between the first mobile station (MS1) and the base station (BS), and to receive access requests from a first group of mobile stations (MS2, MS3) for which channel reservation momentarily cannot be carried out, **characterized in that:**

- the base station (BS) is arranged to give access confirmations (4, 5) to each of the mobile stations (MS2, MS3) which are included in the first group and from which access requests have been received;
- the base station (BS) is arranged to include these access confirmations in the same channel reservation message (2) as said channel reservation (3) for the first mobile station (MS1);
- the base station (BS) is adapted to arrange a queue of the mobile stations (MS2, MS3) in the first group, a queue position being allocated to each mobile station; and
- the base station is arranged to carry out channel reservation for the mobile stations in the first group according to their queue positions.

7. Mobile station in a radio communication system which is arranged for packet data transmission via at least one time-divided channel (Ch1) between the base station (BS) and mobile stations (MS1 - MS3), according to a message-synchronized ALOHA protocol with reservation, the mobile stations being arranged to send access requests to the base station, which is arranged to receive and comply with access requests from at least a first mobile station (MS1) by sending thereto a channel reservation message (2) comprising a channel reservation (3), whereby time slots are reserved for packet data transmission between the first mobile station (MS1) and the base station (BS), and to receive the access requests from at least a second mobile station (MS2) for which channel reservation temporarily cannot be carried out, **characterized in that:**

- a mobile station (MS2) which has sent the access request to the base station

is arranged to read each channel reservation message (2) in the time-divided channel (Ch1); and

- the mobile station (MS2) which has sent the access request to the base station (BS) is arranged to receive an access confirmation (4) in this channel reservation message (2) when the channel reservation (3) does not concern this mobile station (MS2), whereupon the mobile station (MS2) is actuated to await channel reservation without further access requests being sent.