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Optimised operations for research in adjacent channels and for allocating optimised time slots for mobile stations transmitting in a plurality of time slots

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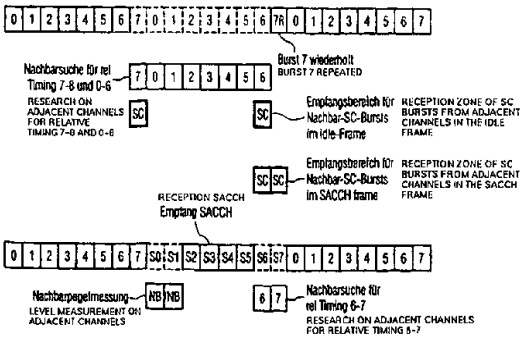
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(54) Title: OPTIMISED OPERATIONS FOR RESEARCH IN ADJACENT CHANNELS AND FOR ALLOCATING OPTIMISED TIME SLOTS FOR MOBILE STATIONS TRANSMITTING IN A PLURALITY OF TIME SLOTS

(54) Bezeichnung: OPTIMIERTE NACHBARKANALSUCHE UND TIMESLOTZUWEISUNG FÜR MEHRFACHZEITSCHLITZ–MOBILSTATIONEN

(57) Abstract

The present invention relates to a system and a method for transmitting data packets between at least one base station (1,9) and at least one mobile station (5) in a mobile radio–telephone system. The data packets are each time transmitted in time frames comprising a fixed number of time slots, and the mobile station is capable of transmitting five data packets in a plurality of successive time slots. While the mobile station (5) communicates with a base station (1) at a given moment, an emitting unit (3) of said base station (1) either sends control data packets or sends no data packet during predetermined time slots. This method is characterised in that a reception unit (6) in the mobile station (5) is provided each time with a time interval which is longer than a predetermined time frame for receiving timing data packets and/or for measuring the signal levels of adjacent base stations (9).



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Abstract

Optimized adjacent channel search and timeslot assignment for multiple timeslot mobile stations

The present invention relates to a system and a method for transmission of data packets between at least one base station (1, 9) and at least one mobile station (5) in a mobile radio system, in which the data packets are each transmitted in time frames which comprise a fixed number of timeslots, and the mobile station (5) can transmit five data packets in a plurality of successive timeslots, in which, while the mobile station (5) is connected to a present base station (1), a transmitting unit (3) of the present base station (1) transmits control data packets or no data packets during predetermined time frames, characterized in that a time interval which is longer than a predetermined time frame is in each case made available to a receiving unit (6) of the mobile station (5) in order to receive synchronization data packets and/or to measure signal levels of adjacent base stations (9).
(Figure 2)

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Description

Optimized adjacent channel search and timeslot assignment for multiple timeslot mobile stations

The present invention relates to a method for transmission of data packets between at least one base station and at least one mobile station in a mobile radio system as claimed in the precharacterizing clause of claim 1, and to a system for transmission of data packets between at least one base station and at least one mobile station in a mobile radio system, as claimed in the precharacterizing clause of claim 10.

Such a method and such a system for transmission of data packets between at least one base station and at least one mobile station in a mobile radio system are known from the prior art. During a call, that is to say when connected, a mobile station in a mobile radio system regularly has to search predetermined frequencies for data packets from adjacent base stations, and to recognize their identity, while it is connected to a present base station. The recognition of identity is generally carried out by decoding the so-called BSIC (base station identity code) in the synchronization data packet. To do this, each base station regularly transmits synchronization data packets. In the GSM Standard, the base stations transmit a synchronization data packet every 10 or 11 time frames, lasting for one timeslot, and with eight timeslots forming a frame.

In the GSM Standard, when a mobile station is making a call, it can monitor an adjacent channel every 26 frames, for a period of somewhat more than one time frame. This one predetermined time frame is the so-called idle frame, in which the mobile station does not interchange any data with the present base station. The predetermined time frame is used to monitor adjacent channels and, possibly,

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to find and to decode synchronization data packets from adjacent base stations. In the GSM Standard, the base stations transmit five synchronization data packets, with a duration of one timeslot, within in each case one multiframe, comprising 51 time frames. These synchronization data packets are transmitted four times every 10 frames and then once after 11 frames, by the base stations. Since the mobile station has a predetermined time frame for monitoring the adjacent channels available every 26 time frames, a mobile station can receive a synchronization data packet from an adjacent base station after at most 11 blank time frames, irrespective of the relative timing of the synchronization data packets of the base stations.

Standard mobile stations in the GSM system use only one of eight possible timeslots per time frame for interchanging data with a respective base station. In order to allow higher data rates to be achieved, multiple timeslot mobile stations have been defined (the GSM term is HSDSC) which, in the extreme, can receive and/or transmit data in up to all eight timeslots. The present invention relates in particular to such multiple timeslot mobile stations.

As has been mentioned above, a standard mobile station can monitor an adjacent channel, while making a call, every 26 frames for a period of somewhat more than one time frame, that is to say approximately nine timeslots. This is necessary since the respective base station and the mobile station are not yet synchronized, and the respective timeslots may be shifted with respect to one another. In multiple timeslot mobile stations, a problem that arises is that the time frames before and after the predetermined time frame may be occupied by the transmission of data packets, and that, in this case, the predetermined time frame with eight timeslots is too short to allow a synchronization data packet from an adjacent base

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station to be received and studied reliably. There is thus a critical relative phase area in which the

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synchronization data packet (SC burst) is located in such an unfavorable manner that it cannot be received and decoded. This is precisely what happens if the synchronization data packet overlaps the boundary of the predetermined time frame. This situation is shown in Figure 12.

In Figure 12, solid lines are used to show the time frames with timeslots 0, 1...7 in which a mobile station receives data packets from a present base station. The predetermined time frames which are available for reception of synchronization data packets and/or for measurement of signal levels of adjacent base stations as well are identified by dashed lines. In this case, the upper line shows the timing sequence for the time around a predetermined time frame, during which the base station does not transmit any data packets, and the lower line shows the timing sequence at a later time, with subsequent predetermined time frame, during which the base station is transmitting SACCH data packets. The time axes have in this case been chosen so that the timing of the synchronization data packet (SC burst) from the adjacent base station is the same. S0 to S7 are in this case the timeslot numbers of the SACCH channel, while 0 to 7 are in each case timeslot numbers for the wanted data channels. The two small boxes with bold boundaries represent the two critical locations of the synchronization data packet from the adjacent base station, which are each located directly at the boundary of the predetermined time frame. If the mobile station switches to reception of synchronization data packets from the adjacent base station only during the eight time frames which are available during the predetermined time frame, then the synchronization data packets which arrive from the adjacent base station in one of the indicated locations cannot be completely received, and thus cannot be decoded and used.

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In order to allow this problem to be overcome, a second receiver is therefore provided in known multiple timeslot mobile stations

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and is used specifically for reception of synchronization data packets and/or for measurement of signal levels from adjacent base stations. This second receiver is thus operated in parallel with the first receiver and is used during the entire time interval that is required for monitoring and/or reception of synchronization data packets from adjacent base stations. However, the use of a second receiver is costly and wastes energy.

The object of the present invention is thus to provide a method for transmission of data packets between at least one base station and at least one mobile station in a mobile radio system as claimed in the precharacterizing clause of claim 1, and to provide a system for transmission of data packets between at least one base station and at least one mobile station in a mobile radio system as claimed in claim 10, in neither of which cases there is any need to use a second receiver in the mobile stations.

This object is achieved by a method for transmission of data packets between at least one base station and at least one mobile station in a mobile radio system as claimed in claim 1, and by a system for transmission of data packets between at least one base station and at least one mobile station in a mobile radio system as claimed in claim 10.

The method for transmission of data packets as claimed in claim 1 is in this case characterized in that the time interval which is longer than a predetermined time frame is in each case made available to the mobile station in order to receive synchronization data packets and/or signal levels of adjacent base stations.

In a corresponding manner, the system for transmission of data packets as claimed in claim 10 is characterized in that a time interval

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which is longer than a predetermined time frame is in each case made available to a receiving unit of the mobile station in order to receive synchronization data packets and/or to measure signal levels of adjacent base stations.

The present invention thus advantageously avoids the use of a second receiver in the base station, thus allowing the costs and the energy consumption in the base station to be reduced considerably.

Advantageous refinements of the present invention are specified in the respective dependent claims.

Advantageously, the mobile station is switched, during the time interval, to reception of synchronization data packets and/or to measurement of signal levels of adjacent base stations. It is also advantageous for the mobile station at least partially not to receive the data packet transmitted by the transmitting unit of the present base station in each case immediately before and/or after a predetermined time frame.

In this case, the data packet transmitted by the present base station immediately before or after the predetermined time frame is advantageously transmitted once again at the end or at the start of the predetermined time frame. Alternatively, the data packet transmitted by the present base station immediately before or after the predetermined time frame can be transmitted once again during the predetermined time frame and, in this case, can be received by the mobile station.

Furthermore, those data packets which are at least partially not received are reconstructed by the mobile station, in an advantageous manner, by means of the redundant coding and the other received data packets.

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The length of the time interval during which the mobile station is switched to reception of synchronization data packets from adjacent base stations is advantageously chosen such that the mobile station can receive a first part of a synchronization data packet in a first time interval, and can receive a second part of a synchronization data packet in a second time interval. In this case, the first part and the second part may each contain at least one section of the training sequence of the synchronization data packet which allows a respective channel equalization to be determined.

Advantageously, a first mobile station transmits data packets and is switched to reception of data packets at different times, with a second mobile station being switched to reception of data packets in timeslots in which the first mobile station is transmitting data packets, and transmitting data packets in timeslots in which the first mobile station is switched to reception of data packets.

The present invention will be explained in more detail in the following text using exemplary embodiments and with reference to the attached drawings, in which:

Figure 1 shows a basic arrangement of a mobile radio system with a present base station, an adjacent base station and a mobile station,

Figure 2 shows a first exemplary embodiment of the present invention,

Figure 3 shows a second exemplary embodiment of the present invention,

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Figure 4 shows a third exemplary embodiment of the present invention,

Figure 5 shows a fourth exemplary embodiment of the present invention,

Figure 6 shows a fifth exemplary embodiment of the present invention,

Figure 7 shows a sixth exemplary embodiment of the present invention,

Figure 8 shows a seventh exemplary embodiment of the present invention,

Figure 9 shows an illustration of the critical overlapping area in multiple timeslot mobile stations,

Figure 10 shows an eighth exemplary embodiment of the present invention,

Figure 11 shows a ninth exemplary embodiment of the present invention, and

Figure 12 shows the critical position of synchronization data packets in a mobile radio system from the prior art.

Figure 1 shows the basic design of a mobile radio system with a present base station 1, which comprises a receiving unit 2, a transmitting unit 3 and a common antenna 4. Furthermore, a mobile station 5 is provided, which has a receiving unit 6, a transmitting unit 7 and a common antenna 8, while an adjacent base station 9 is likewise provided, and likewise comprises a receiving unit 10, a transmitting unit 11 and a common antenna 12. The mobile station 5 is connected to the present base station 1 to make a

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call and, during predetermineed time frames, during which the present base station 1 does not transmit any data packets or control data packets, such as SACCH data, to the mobile station 5, switches to reception of synchronization data packets and/or to measurement of signal levels from the adjacent base station 9. In this case, according to the present invention, the receiving unit 6 of the mobile station 5 switches to reception of synchronization data packets and/or to measurement of signal levels, inter alia, from the adjacent base station 9 in each case during a time interval, or a portion of a time interval, which is longer than a predetermined time frame.

A common feature of the exemplary embodiments of the present invention shown in Figure 2 to Figure 7 is that the transmitting unit 3 of the present base station 1 once again transmits a data packet, which has been sent to the mobile station 5 and is located immediately before or after the predetermined time frame. In this case, in the exemplary embodiments in Figures 2, 3, 4, 5 and 7, the data packet which has been transmitted once again is transmitted once again at the end or at the start of the predetermined time frame while, in the exemplary embodiment in Figure 6, the transmitting unit 3 of the present base station 1 once again transmits the data packet, which has been transmitted once again, during the predetermined time frame, and the receiving unit 6 of the mobile station 5 receives this data packet during the predetermined time frame as well.

The illustration of the exemplary embodiments in Figures 2 to 7 corresponds to the illustration in Figure 12. The topmost line in each case shows the data packets transmitted by the present base station 1 in the timeslots 0 to 7 by solid lines, while a predetermined time frame during which the base station 1 does not transmit any data packets is shown by the dashed lines. The search by the mobile station 5 for

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synchronization data packets and the measurement of signal levels from the adjacent

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base station 9 each take place in the timeslots 0 to 7, which are shown in the second line and are represented by solid lines. The small boxes with bold boundaries, which identify the critical positions of the synchronization data packets (SC bursts) transmitted by the adjacent base station 9 (see Figure 12) are not shown in Figures 2-7 and 9-11. In a standard mobile station, the measurement of the signal levels and of the adjacent field strengths is carried out in a timeslot which is not used for transmission or reception, and with a multiple timeslot mobile station this can likewise be done in the predetermined time frame. This option is shown in the figures by the small boxes denoted NB, which identify timeslots in which the mobile station 5 measures the field strength of the channels and/or the signal levels of adjacent base stations.

Furthermore as is shown by way of example in the exemplary embodiments in Figures 2 and 3, it is possible for the mobile station 5 not to receive any SACCH data packets, or not to receive all of them, from the base station in specific timeslots of the SACCH time frame. In the present version of the GSM Recommendations, a mobile station has to receive SACCH data packets in all the timeslots of an SACCH time frame and (at least) must also use this information in the timeslots in which it is transmitting. The power of the mobile stations in the uplink is thus regulated. However, it is also possible to dispense with reception of certain timeslots, in which case the mobile station must then use the same power as for the other timeslots. This principle is already used in the downlink in the situation where the mobile station transmits in fewer timeslots than it receives in. The lower lines of the illustrations in Figures 2 and 3 each show such a situation, in which the reception of SACCH data packets in in each case four timeslots of

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the SACCH time frame (S0, S1,..., S7) has been dispensed with.

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Figure 2 shows the first exemplary embodiment of the present invention, in which the present base station 1 once again transmits the data packet from the timeslot 7 immediately before the predetermined time frame at the end of the blank time frame. This redundantly repeated data packet is identified by the small box 7R. This redundant transmission of the last data packet before the predetermined data packet at the end of the predetermined data packet is also carried out in the second to fifth exemplary embodiments.

In the sixth exemplary embodiment, shown in Figure 7, the data packet from the timeslot 0 is transmitted immediately after the predetermined data packet and actually at the start of the predetermined data packet, as is identified by the small box 0R.

A common feature of all the exemplary embodiments shown in Figures 2 to 7 is thus that the data packets which are transmitted in a timeslot at the boundary of the predetermined time frame are transmitted by the base station 1 twice, and the mobile station 5 can then optionally also receive this information at the alternative time, thus gaining additional time to carry out the search for synchronization data packets and/or for measurement of signal levels from the adjacent base station 9. This additionally obtained time is just sufficient to allow the synchronization of the adjacent base stations to be carried out in all the cases that occur.

As the lower line in Figure 2 shows, the receiving unit 6 of the mobile station 5 is switched to reception and measurement of signal levels from adjacent base stations during the first two timeslots S0, S1 of the SACCH time frame. In the last two timeslots 6 and 7 of the SACCH time frame, the receiving unit 6 of the mobile station 5 is switched to reception of synchronization data packets from adjacent base stations.

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In the exemplary embodiment shown in Figure 3, the receiving unit 6 of the mobile station 5 is switched to reception and to measurement of adjacent signal levels in the last timeslot (in this case the timeslot 6) of the time frame 7,0...6 that is used for reception of synchronization data packets from the adjacent base station 9. In the SACCH time frame, the first timeslot S0 is used to measure adjacent levels, while the last three timeslots S5, S6 and S7 are used to search for synchronization data packets. The timeslots S1, S2, S3, S4 of the SACCH frame are received, as intended, by the present base station 1.

In the exemplary embodiment shown in Figure 4, the receiving unit 6 of the mobile station 5 is switched to reception of synchronization data packets from the adjacent base station 9 during all the timeslots 7,0...6. In the next predetermined time frame, which is shown in the lower line in Figure 4, the first six timeslots 0,1...5 are then used for measurement of the signal levels from adjacent base stations, while the last two timeslots 6, 7 are used to search for synchronization data packets.

In the exemplary embodiment shown in Figure 5, the last three timeslots of the predetermined time frame are used for measurement of signal levels from adjacent base stations, while the first five timeslots 7,0,...3 are used to search for synchronization data packets. In the predetermined time frame following this, which is shown in the lower line in Figure 5, the first three timeslots 0, 1, 2 are then used for measurement of signal levels from adjacent base stations, while the last five timeslots 3,4,...7 are used to search for synchronization data packets.

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In the exemplary embodiment shown in Figure 6, the first five timeslots 7,0,...3 of the predetermined time frame are used to search for synchronization data packets from adjacent base stations, while the present base station 1 transmits the data packet 7R once again in the fifth timeslot 4, this being the data packet which it had already transmitted immediately before the blank time frame. In the next three timeslots, the mobile station 5 measures signal levels from adjacent base stations. In the next predetermined time frame, which is shown in the lower line in Figure 6, the signal levels from adjacent base stations are measured in the first three timeslots of the blank time frame, while a search for synchronization data packets is carried out in the following five timeslots 3,4,...7.

In the exemplary embodiment shown in Figure 7, the present base station transmits the data packet in the timeslot 0 immediately after the end of the predetermined time frame, right at the start of the predetermined time frame, as is shown by the small box 0R. In the first three timeslots of the blank time frame, the mobile station 5 measures signal levels from adjacent base stations, while it searches for synchronization data packets in the last five timeslots 4,5,...0. In the next predetermined time frame, which is shown in the lower line in Figure 7, the mobile station 5 searches during the first five timeslots 0,1...4 of the predetermined time frame for synchronization data packets from adjacent base stations, while it carries out a measurement of the signal levels from adjacent base stations in the last three timeslots.

A common feature of all the exemplary embodiments in Figures 2 to 7 is that the mobile station 5 at least partially fails to receive the respective data packet transmitted immediately before and/or after the predetermined time frame, since the single receiving unit 6 of the mobile station 5

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switches to reception of synchronization data packets and/or measurement of signal levels from adjacent base stations during a time period which is longer than a predetermined time frame.

If the transmitting unit 3 of the present base station 1 does not carry out any repetition of data packets whatsoever, the receiving unit 6 of the mobile station 5 can also suppress reception of the last timeslot before the predetermined time frame, or the first timeslot after it. Since, specifically, the data to be transmitted are coded redundantly in the base station 1, the data received by the mobile station 5 can be completely decoded if the field strengths and/or reception conditions are correspondingly good. However, if the reception conditions are not optimal, increased error rates can be expected. If the data packets in the two timeslots at the boundary of the predetermined time frame were both partially not received, this would result in a better distribution of any existing bits so that, in this case as well, adequate reception quality may be obtained in relatively poor reception conditions.

In the seventh exemplary embodiment of the present invention, shown in Figure 8, the length of the time interval during which the receiving unit 6 of the mobile station 5 switches to reception of synchronization data packets and/or measurement of signal levels from adjacent base stations, is chosen such that the receiving unit 6 of the mobile station 5 can receive a first portion of a synchronization data packet in a first time interval, and can receive a second portion of a synchronization data packet in a second time interval.

In Figure 8, the first time interval is represented by the dashed small boxes 0,1...7 in the first line, while the second time interval is likewise identified in the second line by dashed small boxes

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0,1...7. If the same data are always coded in the synchronization data packet, it will be possible simply to receive this burst in two parts, firstly bit Nos. 3 to 105 (the first half), with bit Nos. 42 to 144 (the second half) being received later. The training sequence (bit Nos. 42 to 105) must in this case be received twice, since they are required to assess the channel distortion, which is then used for equalization of the wanted data. However, a shorter section for the training sequence could also be sufficient for this purpose, as a result of which the necessary time interval is further shortened. The training sequence of the synchronization data packet is of such a length that it can easily be found by correlation. A shorter training sequence will be sufficient to assess the channel impulse response. However, it would then be necessary to solve an equation system rather than using the correlation method. Depending on the reception conditions, the necessary portion of the training sequence may also be shorter or longer.

However, the data in the synchronization data packet are not constant but also contain the respective time frame number. This time frame number is contained in coded form in the respective training sequence. If the time frame number is decoded, then only a single bit changes in the majority of cases. This change by one bit can be represented by an exclusive-OR operation. The nature of the coding of the synchronization data packet (convolution code and fire code) makes it relatively easy to carry out such an exclusive-OR operation on the coded bits as well, and thus to use the first half of the synchronization data packet received at one time to calculate the half of the synchronization data packet which was not received at another time. In the case of convolution codes, the relevant coded bits just need to be inverted, and with fire codes, the corresponding polynomial division

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governs the bits to be changed before use of the convolution code, and the bits to be inverted.

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Decoding can thus be carried out in a known manner. This decoding is, of course, successful only in 50% of cases, in which only one bit is actually different. If the decoding fails, then the cases in which the corresponding bits of the coded time frame number in the training sequence change may then also be considered successively. As an alternative, a further decoding attempt may also be made at a later time. This time would be 26 + (4 or 5) x 51 = 230 or 281 time frames later.

In this exemplary embodiment of the present invention, the time interval in which the mobile station is switched to reception of synchronization data packets from adjacent base stations does not need to be nine timeslots long, but eight timeslots plus the length of the portion of the training sequence required for channel assessment + the length of one data half of the synchronization data packet. The time for the second data half of the synchronization data packet, possibly plus the portion of the training sequence which is not required for decoding, is thus saved. Wanted data packets may be received in this time that is saved.

The seventh exemplary embodiment is advantageous, in particular, in combination with one of the preceding exemplary embodiments if, in this exemplary embodiment, the receiving unit 6 of the mobile station 5 requires too much time to change over to the appropriate channel for reception of synchronization data packets from adjacent base stations.

As has already been mentioned above, multiple timeslot mobile stations have been defined in order to increase the data rate over that of standard mobile stations, and they receive and transmit data in a plurality of timeslots. If such a multiple timeslot mobile station has to transmit and receive simultaneously, because transmitting and receiving timeslots are superimposed, then this leads to the

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complexity of the mobile station design being considerably increased, since the transmitting unit and the receiving unit cannot share any common components, such as a synthesizer, power supply, parts of A/D and D/A converters, timing signals, etc., since the receiving unit must be shielded from the transmitter sufficiently well that the transmitter does not interfere with it, resulting in the necessity for more complex shielding measures, and since it is absolutely essential to use a duplexer toward the antenna. However, with the prior art, this advantageous situation is possible only when at most two timeslots are used for transmission and at most five timeslots are used for reception. In the class breakdown for GSM mobile stations, so-called Type 1 mobile stations, that is to say mobile stations which do not transmit and receive at the same time, are thus defined for a limited combination of transmission/ reception timeslots.

Figure 9 shows such an overlap of transmission and reception timeslots in a mobile station. The first line in this case shows the received timeslots 0, 1, 2, 3 by solid lines while, in the second line, the transmitted timeslots 1, 2, 3 are likewise shown by solid lines. The overlap area between the transmitted timeslot 1 and the received timeslot 3 is in this case not equal to zero for a timing advance. The example illustrated in Figure 9 relates to a 4E3S mobile station, in which a maximum of four timeslots are received successively, and a maximum of three timeslots are transmitted successively. Apart from the overlap area, no timeslots are transmitted while timeslots are being received, and vice versa.

The known mobile stations thus have the disadvantage that the overlap between the transmission and reception timeslots explained in Figure 9 means that increased complexity was required for elements in the mobile stations. Furthermore, so-called half-duplex

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mobile stations were introduced. In these mobile stations, the mobile station only receives, but does not transmit, for a predetermined time, and also does not carry out any adjacent channel measurements. The mobile station then has a reception pause in which it carries out adjacent channel measurements, after which it switches to transmission. This is of interest in particular for asymmetric operation, for example when there is a high data rate in the downlink, but a low data rate in the uplink (Internet surfing). A disadvantage with this method is the fact that the transmission capacity of the base station cannot be fully utilized, owing to the pauses.

In the eighth and ninth exemplary embodiments, this problem is countered in that a first mobile station does not transmit data packets while being switched to reception of data packets at the same time, while a second mobile station is switched to reception of data packets in timeslots in which the first mobile station is transmitting data packets, and transmitting data packets in timeslots in which the first mobile station is switched to reception of data packets.

In this case, the first line of Figure 10 uses solid lines to show the timeslots 0, 1, 2, 3 in which data packets are transmitted by a first mobile station while, in the second line, showing those timeslots 2, 3, 4 in which data packets are received by the first mobile station. In the third line, those timeslots 4, 5, 6, 7 are each shown by solid lines in which data packets are received by the second mobile station, while, in the fourth line, those timeslots 6, 7, 0 are in each case shown in which data packets are transmitted by the second mobile station. Those transmission and reception timeslots which would be used for simultaneous transmission and reception in a mobile station are thus shifted in time to other timeslots, with simultaneous

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transmission and reception being impossible. Thus, in fact, the mobile station occupies more timeslots overall, and thus uses more network resources than necessary. However, this is compensated for by the fact that the second mobile station transmits and receives in an interleaved manner such that all eight timeslots per time frame are nevertheless used. The second mobile station may in this case either likewise be a mobile station which transmits according to the invention, or else a conventional multiple timeslot mobile station which, however, transmits in fewer timeslots than the timeslots in which it receives.

The eighth exemplary embodiment, which is shown in Figure 10, illustrates how two 4E3S mobile stations transmit and receive without any overlap. This exemplary embodiment also applies when the second mobile station receives in four timeslots and transmits in two timeslots, in which case the transmission timeslot 0 is then not occupied by the second mobile station (fourth line in Figure 10).

The ninth exemplary embodiment, shown in Figure 11, illustrates the necessary combination with one of the preceding exemplary embodiments 2 to 7. Since, namely, the time to search for synchronization data packets from adjacent base stations in the predetermined time frame takes up less than nine timeslots, one of the exemplary embodiments 2 to 7 must, of course, be used at the same time in order to allow synchronization with adjacent base stations to be carried out. As can be seen in Figure 11, the present base station in this case transmits the data packet of the timeslot immediately after a predetermined time frame immediately before the start of the predetermined time frame, as is shown by the timeslot 0R. The first mobile station, however, carries out a measurement of the signal levels of adjacent base stations in the first three timeslots of the predetermined time frame

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while, in the next five timeslots 4,5, ...0, it searches for synchronization data packets from adjacent base stations. The lower half of

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Figure 11 in this case shows the adjacent channel search for the first mobile station in the next predetermined time frame, in which case the mobile station searches for synchronization data packets from adjacent base stations in the first five timeslots 0,1...4, and measures the signal levels from adjacent base stations in the last three timeslots. The first mobile station, explained by way of example in Figure 11, is likewise a 4E3S mobile station.

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Patent Claims

1. A method for transmission of data packets between at least one base station and at least one mobile station in a mobile radio system,
in which the data packets are each transmitted in time frames which comprise a fixed number of timeslots, and the mobile station can transmit data packets in a plurality of successive timeslots,
in which, while the mobile station is connected to a present base station, the present base station transmits control data packets or no data packets to the mobile station during predetermined time frames,
characterized
in that a time interval which is longer than a predetermined time frame is in each case made available to the mobile station in order to receive synchronization data packets and/or to measure signal levels of adjacent base stations.

2. The method for transmission of data packets as claimed in claim 1,
characterized
in that, during the time interval, the mobile station is switched to reception of synchronization data packets and/or measurement of signal levels of adjacent base stations.

3. The method for transmission of data packets as claimed in claim 1 or 2,
characterized
in that the data packet transmitted by the present base station in each case immediately before and/or after a predetermined time frame is at least partially not received by the mobile station.

4. The method for transmission of data packets as claimed in claim 3,

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characterized

in that those data packets which are at least partially not received are reconstructed by the mobile station by means of the redundant coding of other received data packets.

5. The method for transmission of data packets as claimed in one of the preceding claims,

characterized

in that the data packet transmitted by the present base station immediately before or after the predetermined time frame is transmitted once again at the end or at the start of the predetermined time frame.

6. The method for transmission of data packets as claimed in one of claims 1-4,

characterized

in that the data packet transmitted by the present base station immediately before or after the predetermined time frame is transmitted once again during the predetermined time frame, and is in this case received by the mobile station.

7. The method for transmission of data packets as claimed in one of the preceding claims,

characterized

in that the length of the time interval during which the mobile station is switched to reception of synchronization data packets from adjacent base stations is chosen such that the mobile station can receive a first part of a synchronization data packet in a first time interval, and can receive a second part of a synchronization data packet in a second time interval.

8. The method for transmission of data packets as claimed in claim 7,

characterized

in that the first part and the second part each contain at least one section of the training sequence of the

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synchronization data packet which allows the respective channel equalization to be determined.

9. The method for transmission of data packets as claimed in one of the preceding claims,

characterized

in that a first mobile station transmits data packets and is switched to reception of data packets at different times, with a second mobile station being switched to reception of data packets in timeslots in which the first mobile station is transmitting data packets, and transmitting data packets in timeslots in which the first mobile station is switched to reception of data packets.

10. A system for transmission of data packets between at least one base station (1) and at least one mobile station (5) in a mobile radio system, in which the data packets are each transmitted in time frames which comprise a fixed number of timeslots, and the mobile station (5) can transmit data packets in a plurality of successive timeslots, in which, while the mobile station (5) is connected to a present base station (1), a transmitting unit (3) of the present base station (1) transmits control data packets or no data packets to the mobile station (5) during predetermined time frames,

characterized

in that a time interval which is longer than a predetermined time frame is in each case made available to a receiving unit (6) of the mobile station in order to receive synchronization data packets and/or to measure signal levels of adjacent base stations (9).

11. The system for transmission of data packets as claimed in claim 10,

characterized

in that, during the predetermined time interval, the receiving unit (6) of the mobile station (5) switches to reception of

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synchronization data packets and/or measurement of signal levels of adjacent base stations (9).

12. The system for transmission of data packets as claimed in claim 10 or 11,

characterized

in that the receiving unit (6) of the mobile station (5) at least partially does not receive that data packet which is in case transmitted by the transmitting unit (3) of the present base station (1) immediately before and/or after a predetermined time frame.

13. The system for transmission of data packets as claimed in claim 12,

characterized

in that the mobile station (5) has a processing unit which reconstructs those data packets which have at least partially not been received, by means of the redundant coding of other received data packets.

14. The system for transmission of data packets as claimed in one of claims 10 to 13,

characterized

in that the transmitting unit (3) of the present base station (1) transmits that data packet which was transmitted immediately before or after the predetermined time frame once again at the end or at the start of the predetermined time frame.

15. The system for transmission of data packets as claimed in one of claims 10 to 14,

characterized

in that the transmitting unit (3) of the present base station (1) transmits the data packet which was transmitted immediately before or after the predetermined time frame once again during the predetermined time frame, and the receiving unit (6) of the mobile station (5) receives this data packet.

16. The system for transmission of data packets as claimed in one of claims 10 to 15,

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characterized

in that the length of the time interval during which the receiving unit (6) of the mobile station (5) switches to reception of synchronization data packets from adjacent base stations (9) is chosen such that the receiving unit (6) of the mobile station (5) can receive a first part of a synchronization data packet in a first time interval, and can receive a second part of a synchronization data packet in a second time interval.

17. The system for transmission of data packets as claimed in claim 16,

characterized

in that the first part and the second part each contain at least one section of the training sequence of the synchronization data packet which allows the respective channel equalization to be determined.

18. The system for transmission of data packets as claimed in one of claims 10 to 17,

characterized

in that a first mobile station transmits data packets and is switched to reception of data packets at different times, with a second mobile station being switched to reception of data packets in timeslots in which the first mobile station is transmitting data packets, and transmitting data packets in timeslots in which the first mobile station is switched to reception of data packets.

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FIG 1

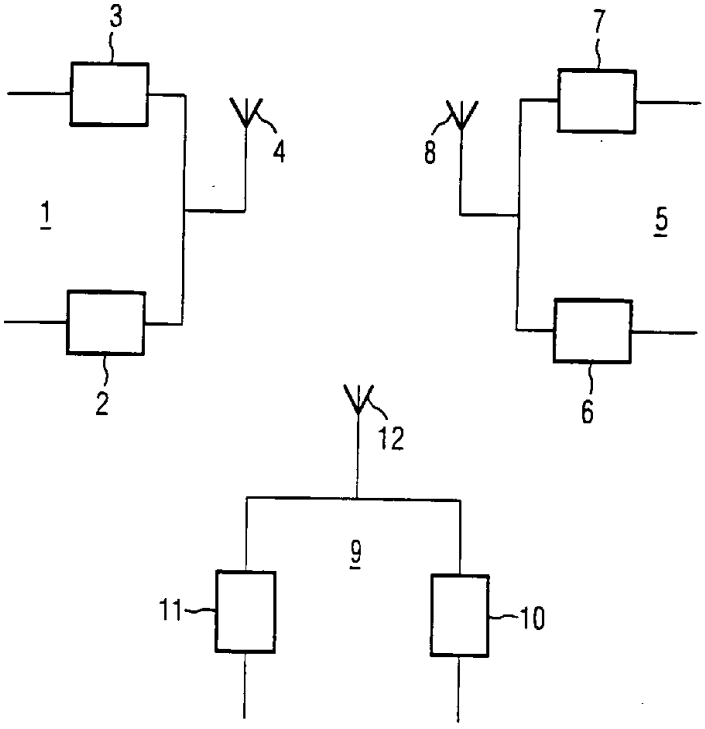


FIG 2

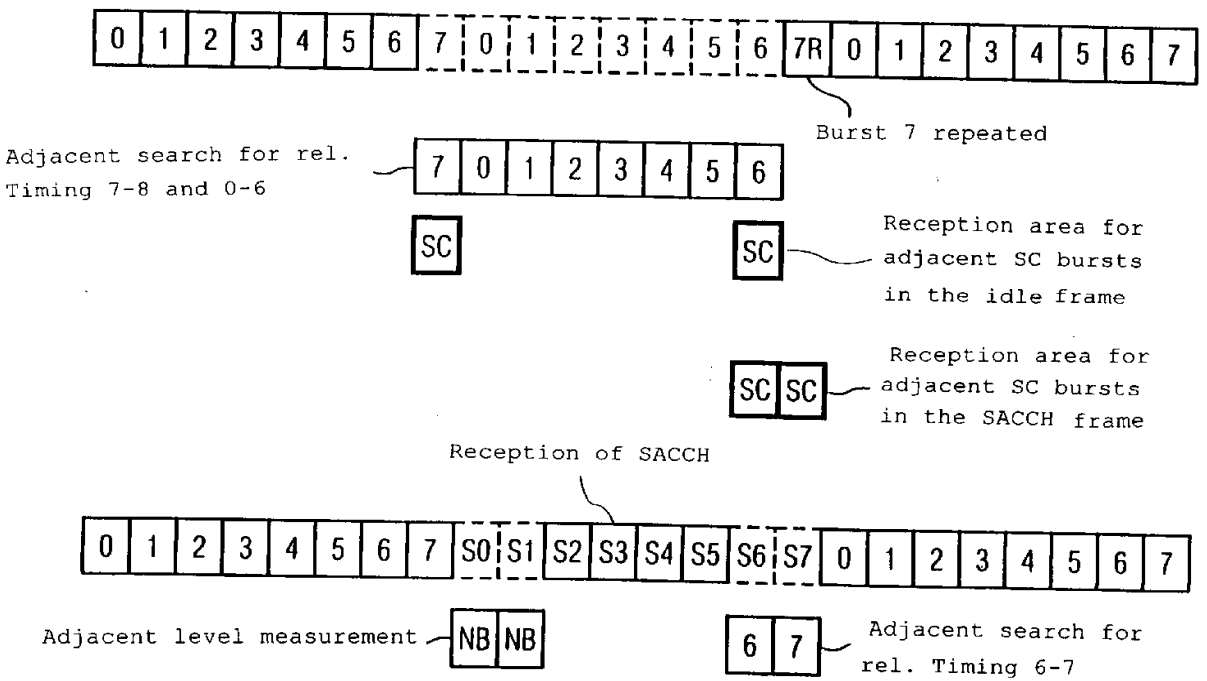

0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7R 0 1 2 3 4 5 6 7
Burst 7 repeated
Adjacent search for rel. Timing 7-8 and 0-6
7 0 1 2 3 4 5 6
SC
SC
Reception area for adjacent SC bursts in the idle frame
SC SC
Reception area for adjacent SC bursts in the SACCH frame
Reception of SACCH
0 1 2 3 4 5 6 7 S0 S1 S2 S3 S4 S5 S6 S7 0 1 2 3 4 5 6 7
Adjacent level measurement
NB NB
6 7
Adjacent search for rel. Timing 6-7

FIG 3

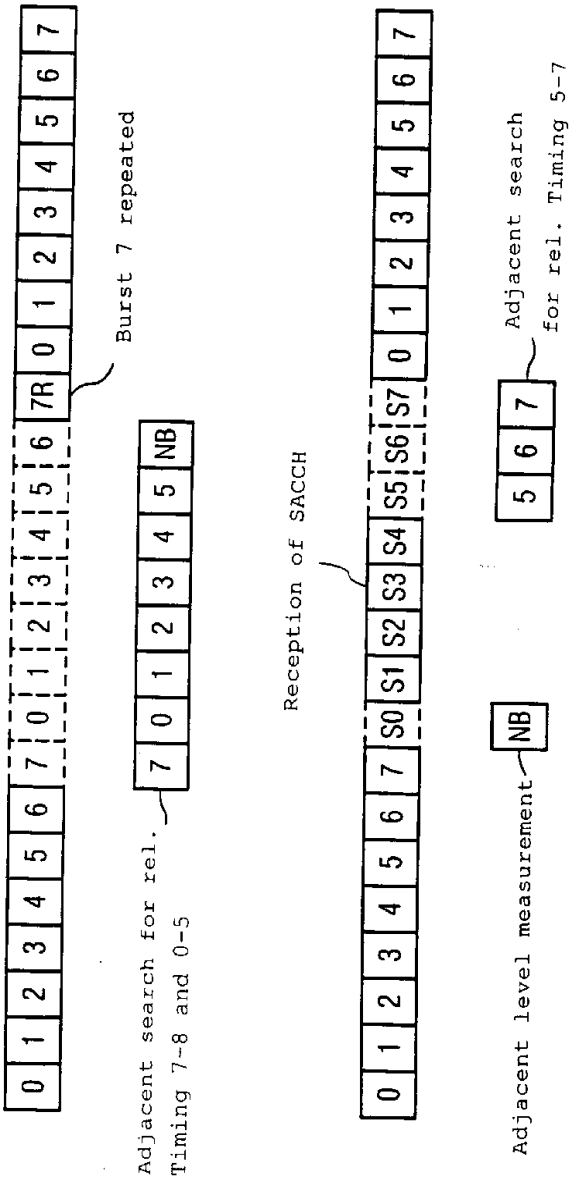

0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7R
Burst 7 repeated
7 0 1 2 3 4 5 NB
Adjacent search for rel. Timing 7-8 and 0-5
Reception of SACCH
0 1 2 3 4 5 6 7 S0 S1 S2 S3 S4 S5 S6 S7 0 1 2 3 4 5 6 7
Adjacent level measurement
NB
5 6 7
Adjacent search for rel. Timing 5-7

FIG 4

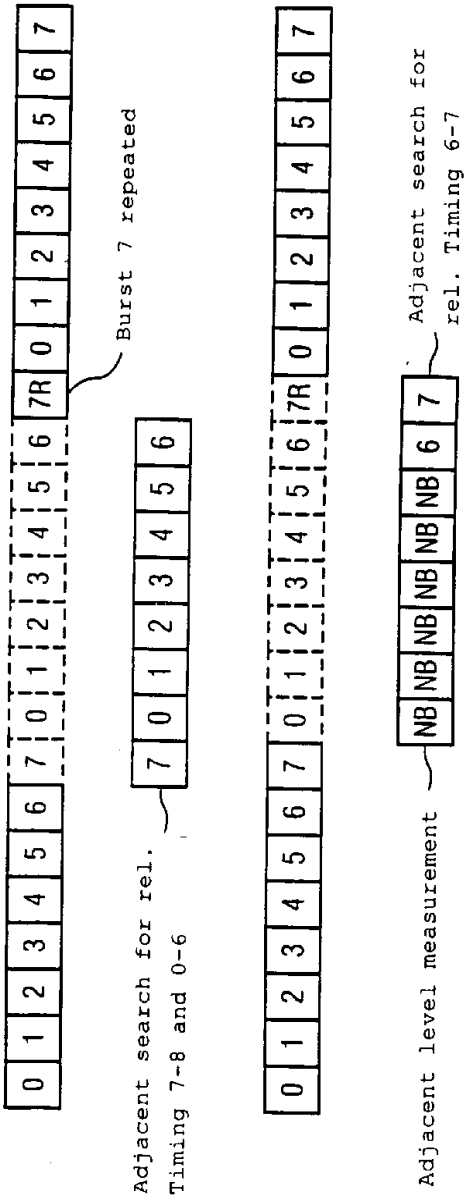

0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7R 0 1 2 3 4 5 6 7
Burst 7 repeated
7 0 1 2 3 4 5 6
Adjacent search for rel. Timing 7-8 and 0-6
0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7R 0 1 2 3 4 5 6 7
NB NB NB NB NB 6 7
Adjacent search for rel. Timing 6-7
Adjacent level measurement

FIG 5

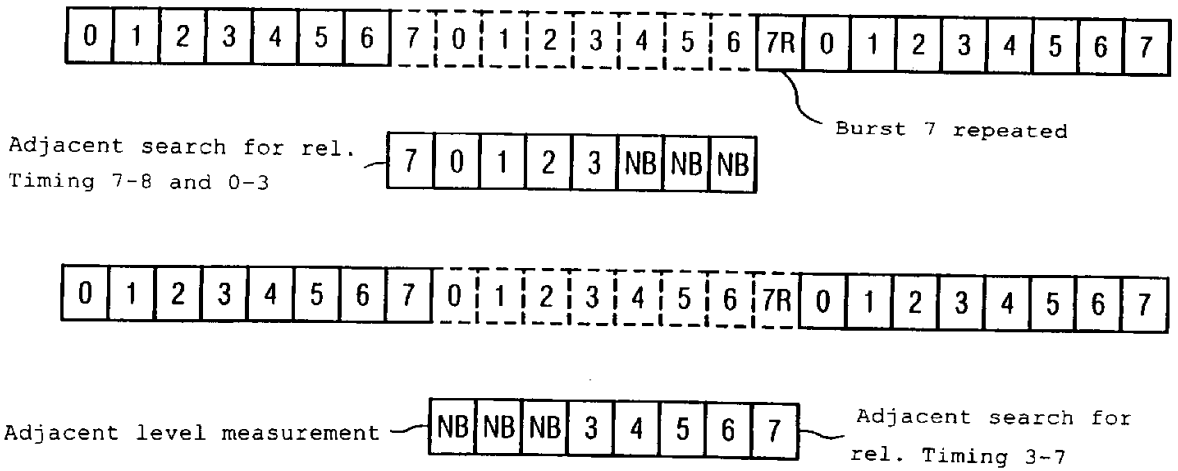

0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7R 0 1 2 3 4 5 6 7
Burst 7 repeated
Adjacent search for rel. Timing 7-8 and 0-3
7 0 1 2 3 NB NB NB
0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7R 0 1 2 3 4 5 6 7
Adjacent level measurement
NB NB NB 3 4 5 6 7
Adjacent search for rel. Timing 3-7

FIG 6

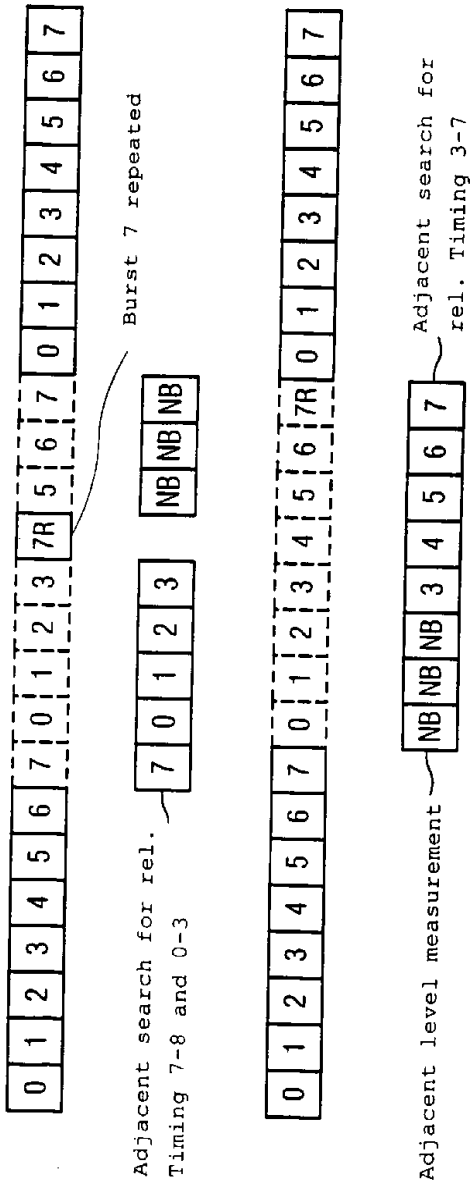

0 1 2 3 4 5 6 7 0 1 2 3 7R 5 6 7 0 1 2 3 4 5 6 7
Burst 7 repeated
Adjacent search for rel. Timing 7-8 and 0-3
7 0 1 2 3
NB NB NB
0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7R 0 1 2 3 4 5 6 7
Adjacent search for rel. Timing 3-7
Adjacent level measurement
NB NB NB 3 4 5 6 7

FIG 7

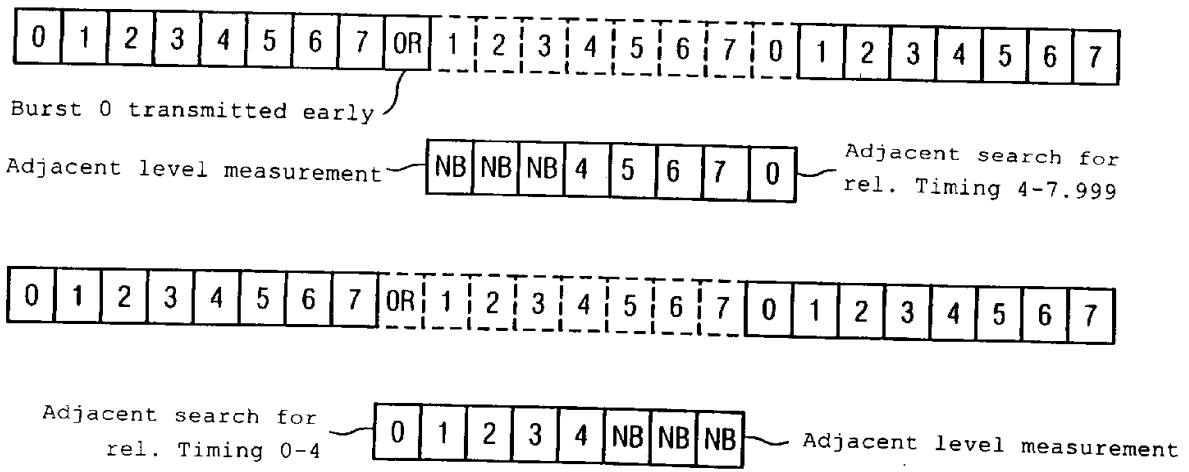

0 1 2 3 4 5 6 7 OR 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7
Burst 0 transmitted early
Adjacent level measurement
NB NB NB 4 5 6 7 0
Adjacent search for rel. Timing 4-7.999
0 1 2 3 4 5 6 7 OR 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7
Adjacent search for rel. Timing 0-4
0 1 2 3 4 NB NB NB
Adjacent level measurement

FIG 8

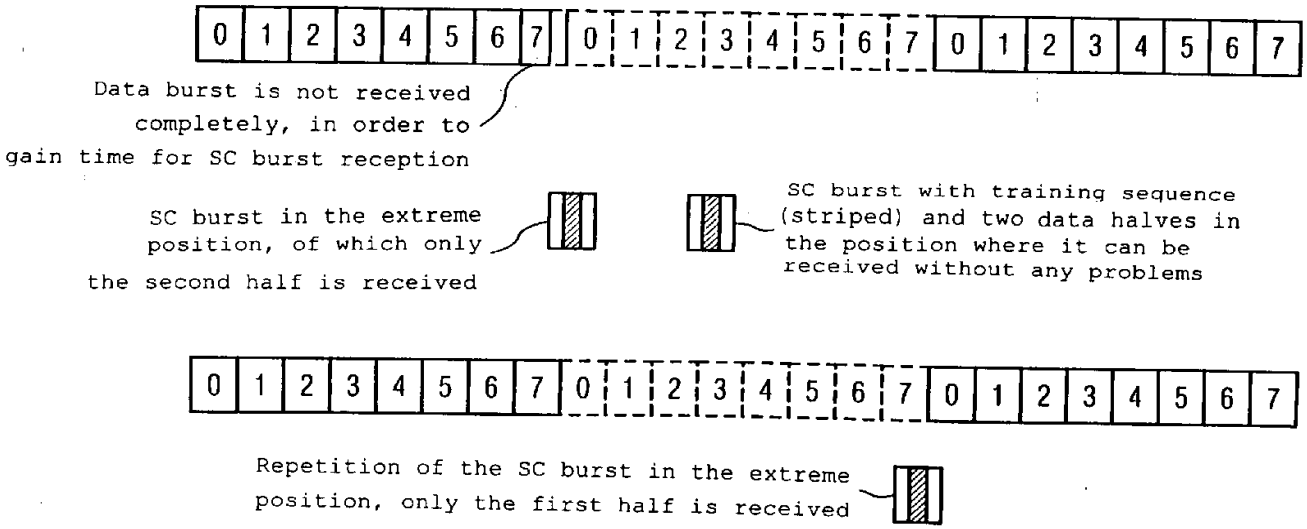

0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7
Data burst is not received completely, in order to gain time for SC burst reception
SC burst in the extreme position, of which only the second half is received
SC burst with training sequence (striped) and two data halves in the position where it can be received without any problems
0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7
Repetition of the SC burst in the extreme position, only the first half is received

FIG 9

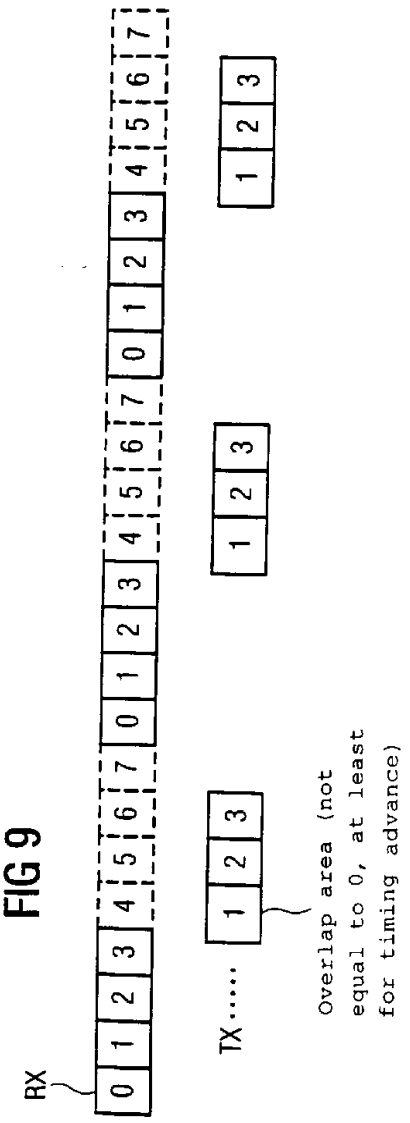

RX
0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7
TX.....
1 2 3
1 2 3
1 2 3
Overlap area (not
equal to 0, at least
for timing advance)

FIG 10

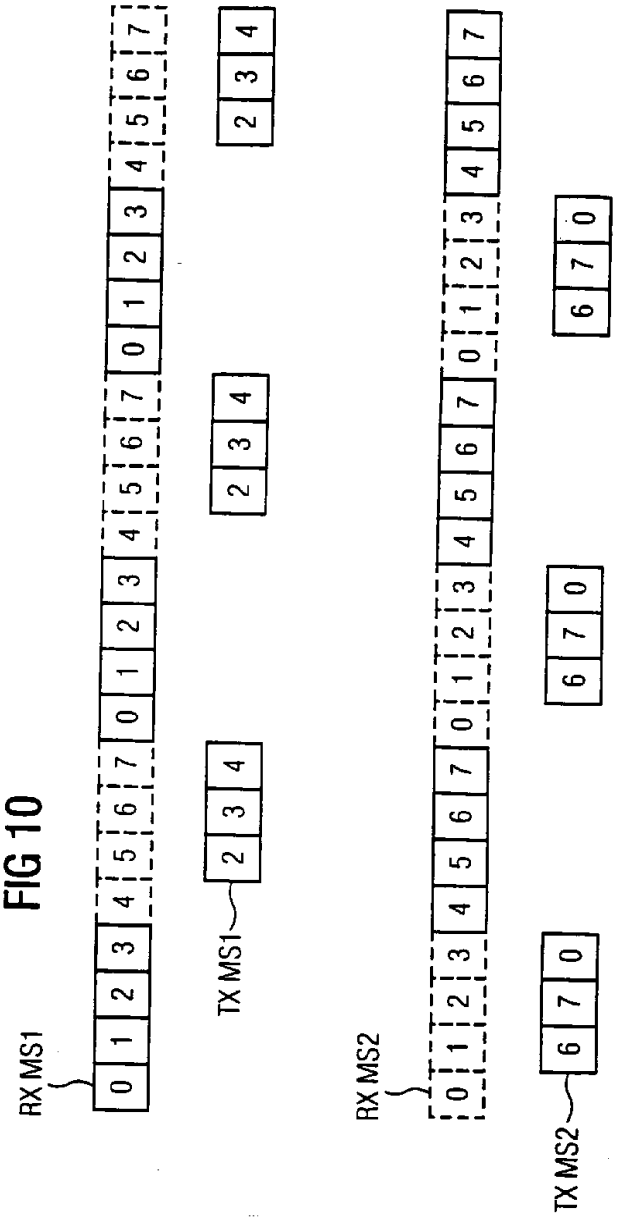

RX MS1
0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7
TX MS1
2 3 4
2 3 4
RX MS2
0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7
TX MS2
6 7 0
6 7 0

FIG 11

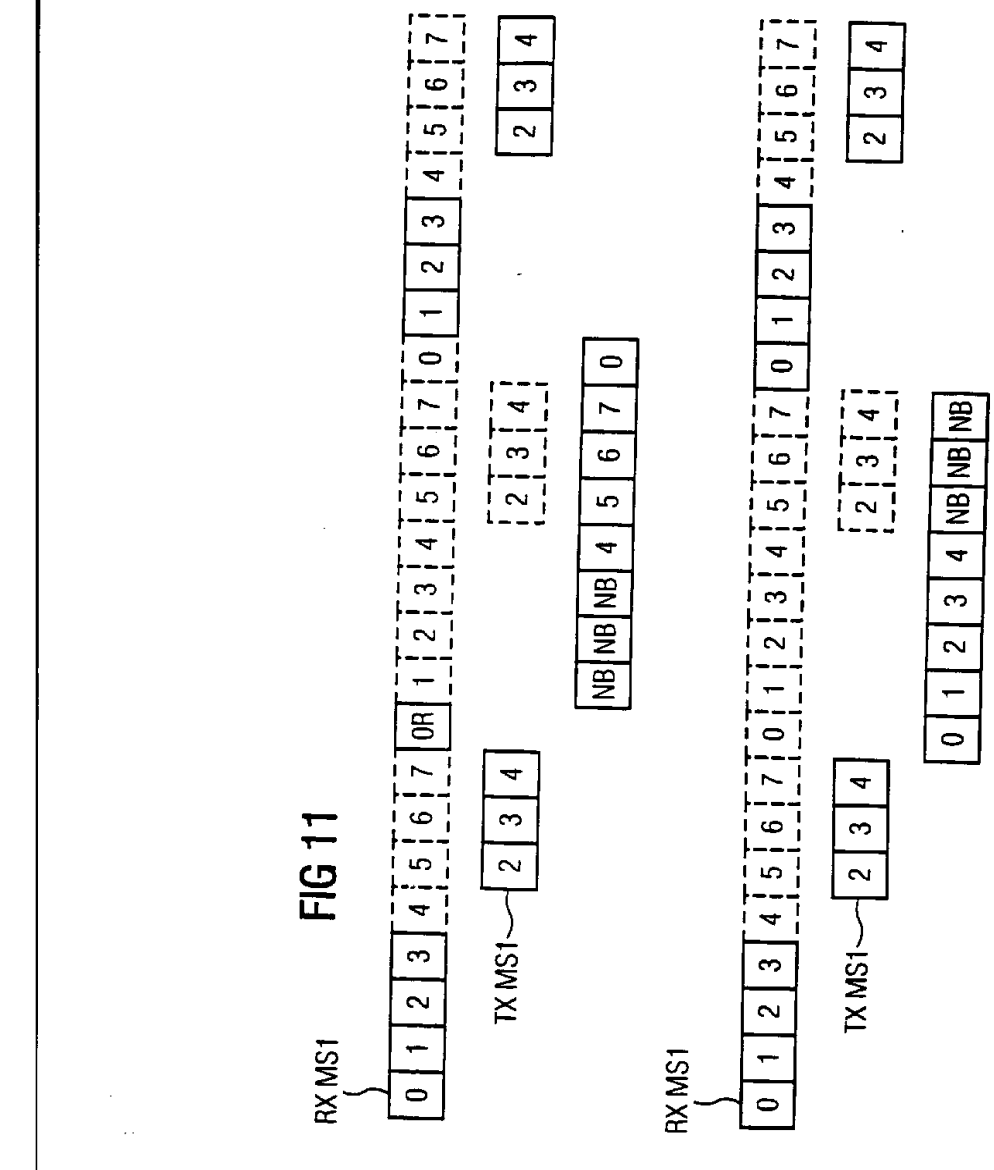

RX MS1
0 1 2 3 4 5 6 7 OR 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7
TX MS1
2 3 4
2 3 4
NB NB 4 5 6 7 0
RX MS1
0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7
TX MS1
2 3 4
2 3 4
0 1 2 3 4 NB NB

FIG 12

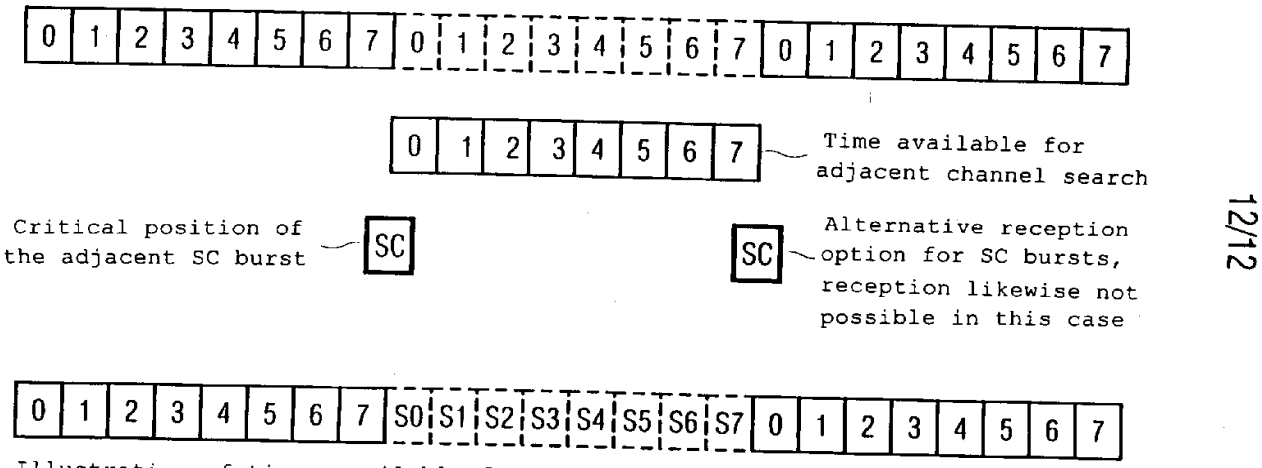


Illustration of times available for adjacent channel search and SACCH. Critical position of the adjacent sync burst