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(71) Applicant *(for all designated States except US):* TELEFONAKTIEBOLAGET LM ERICSSON (PUBL) [SE/SE]; S-164 83 Stockholm (SE).

(72) Inventor; and
(75) Inventor/Applicant *(for US only):* DE POMIAN, Erik [SE/SE]; Edsviksvagen 112, S-191 43 Sollentuna (SE).

(74) Agent: NILSSON, Charlotte; Ericsson AB, Patent Unit 3G, S-164 80 Stockholm (SE).

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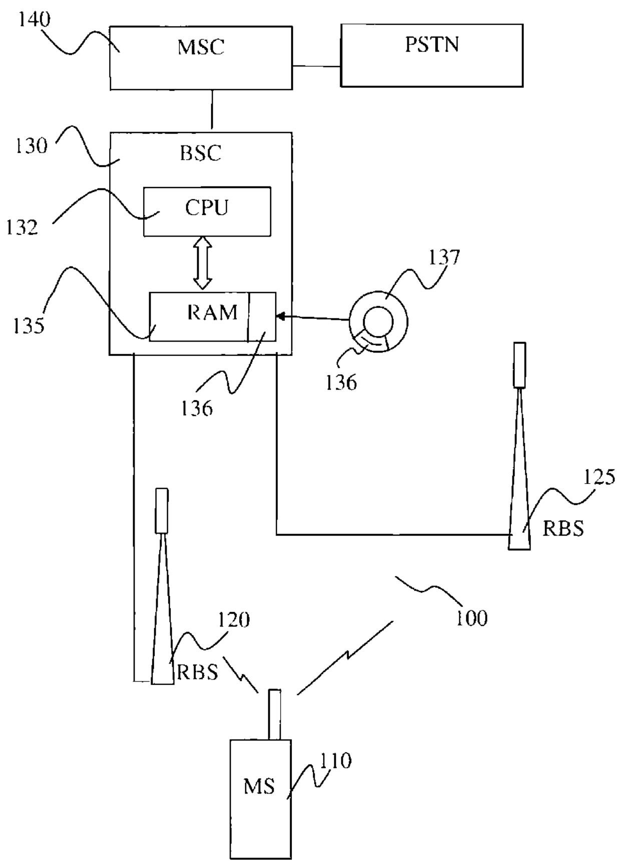
(54) **Title:** USER DATA BIT RATE ALLOCATION SCHEME FOR CELLULAR RADIO NETWORKS



(57) Abstract: The invention relates generally to cellular radio networks and more specifically provides a method and means for improving the communication connection characteristics for cellular network connections and increases overall network capacity. According to one aspect, the invention provides a cellular radio network node (130) comprising: - channel allocation and updating means (150) for allocating a traffic channel to a mobile station, MS (110); the traffic channel having a suitable user data bit rate selected among a plurality of possible user data bit rates, and for dynamically updating the user data bit rate of such a traffic channel being allocated to the MS (110), wherein said channel allocation and updating means (150) is arranged for: - receiving, from a signal strength estimating means (160). an estimate of the received signal strength, SS_{EST}- of a channel as received at the MS (110), and - selecting the suitable user data bit rate as a function of said estimated signal strength. SS_{EST}.

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USER DATA BIT RATE ALLOCATION SCHEME FOR CELLULAR RADIO NETWORKS

TECHNICAL FIELD OF THE INVENTION

The invention relates generally to cellular radio networks and more specifically to the subject matter of the pre-characterising portion of the independent claims 1, 12 and 24.

BACKGROUND

There is a constant need to increase the cellular network operator's revenues, and therefore the traffic channel capacity of cellular radio networks. Many channel allocation schemes have been proposed/implemented to meet this need. An example of one such scheme is the DYMA-scheme (Dynamic FR/HR Mode Adaptation) which has been proposed for the GSM system. FR/HR mode adaptation means that FR- and HR traffic channels are re-allocated continuously, i.e. a user bit rate change is taking place, in order to pack the channels in an optimal manner so as to increase the network capacity. The DYMA scheme makes intelligent dynamic allocation of FR- (Full Rate) and HR- (Half Rate) channels to MSs (Mobile Stations) in order to create/exploit as many simultaneous traffic channels as possible, from the available traffic channel resources of the network. FR-channels may be divided into HR-channels which are packed together to increase the total capacity. The packing criterion is based on traffic load and traffic channel quality in form of BER-estimates. Thus, the DYMA scheme makes an intelligent trade-off between connection quality and traffic channel quantity, sacrificing (speech) quality (for some intelligently chosen individual MS/s) for increasing the network's overall traffic channel quantity.

Interference constitutes a problem for conventional cellular radio networks, such as "DYMA-scheme networks", since interference deteriorates the quality of a (traffic) channel and may even give rise to a dropped call, i.e. the (traffic) channel is being shut down. Many dropped calls leads to increased network signaling, at least in a statistical sense, since call-re-setup requires extra network signaling, which is of course undesirable. Furthermore, call drops are inconvenient for end users. Thus, interference deteriorates the communication connection characteristics of cellular radio networks. In order to increase the operator's revenues, it is thus important to find methods/means which decrease the risk of dropped calls, increase the capacity of the network and which combat interference. It is important to find methods/means which improve the communication connection characteristics of cellular radio networks.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide methods and means which improve the communication connection characteristics of cellular radio networks.

The invention is based on an identified higher call drop rate in case the DYMA algorithm is active in comparison with exploiting only FR-, or only HR-channels, i.e. DYMA not being active, along with an understanding of the real causes of this increased call drop rate. This increased call drop rate is due to the fact that the traffic channels are dropped when it is not possible to decode the signaling channels, e.g. the SACCH or FACCH in case of a GSM system. Since traffic channels generally are more "interference/path loss" resistant than the signaling channels, and this is particularly the case when AMR speech coding is employed, a call with a perceived good quality may be dropped in high interference/path loss environments. The concept of the present invention is to use the signal strength estimate of a channel as received by a mobile station, MS, rather than a traffic channel quality estimate such as BER, for controlling the allocation/exploitation and intra-cell handovers of FR/HR traffic channels. This allows for an effective restriction of where/when FR- and HR allocation/exploitation may take place and where/when a FR/HR- or HR/FR intra-cell handover may take place, e.g. only in an advantageous area within a cell where the risk of call drops due to such high interference/path loss intra-cell handovers is relatively low. The invention is based on the insight that traffic channel quality estimates as the BER at the MS can not be used for an effective HR/FR- or FR/HR- intra-cell handover control, since the BER is affected by the traffic load (both of serving and/or neighbouring cell/s), while this is not the case for the "raw" received signal strength exploited by the invention. Furthermore, the BER of a traffic channel (i.e. timeslot) may vary considerably between a current (timeslot) and a previously exploited HR/FR-channel (timeslot) after intra-cell handover while the signal strength of a channel received at the MS is basically position dependent only. The invention is based on the idea to prevent HR-FR changes within a low quality area of the cell (low absolute and/or relative signal strength condition/s) and instead make such changes where the quality of the signaling channel (FACCH) is good enough for allowing a intra-cell handover with low "call drop risk", i.e. the signaling channel will most probably be decoded correctly.

According to a first aspect, the invention provides a cellular radio network node comprising:

channel allocation and updating means for allocating a traffic channel to a mobile station. MS: the traffic channel having a suitable user data bit rate selected among a plurality of possible user data bit rales, and for dynamically updating the user data bit rate of such a traffic channel being allocated to the MS.

wherein said channel allocation and updating means is arranged for:

receiving, from a signal strength estimating means, an estimate of the received signal strength, $SS_{ES}\tau$, of a channel as received at the MS. and

selecting the suitable user data bit rate as a function of said estimated signal strength, SS_{EST}.

This allows for the creation of a "cell core area" outside which FR/HR-intra-cell handovers are not allowed and thus provides a possibility to control FR/HR exploitation and FR/HR intra-cell handovers so as to decrease the overall call drop rate and/or increase the overall capacity of the network.

The channel allocation and updating means may comprise:

means for comparing said $SS_{ES}\chi$ with a predefined threshold value, T.

means for blocking the dynamic updating of the user data bit rate of the allocated traffic channel if said SS_{EST} is below said T.

This blocking decreases the call drop rate (due to decreased overall signaling) since FR/HR-intra-cell handovers are not being made near the cell border and/or where the interference conditions are bad.

The SS_{EST} may represent an absolute received signal strength. as received at the MS. for a traffic channel allocated to the MS. or for a beacon channel signal from the base station currently serving the MS, such as a BCCH-channel.

This gives an absolute channel quality estimate indicative of path loss from the serving base station. allowing for an advantageous blocking (of data bit rate updating) criterion in case of e.g. an omni directional cell lacking neighboring cell/s.

The $SS_{E}s\tau$ may be a relative signal strength estimate between a channel received at the MS from a currently serving base station and a channel received at the MS from a neighboring base station. so that the $SS_{E}s\tau$ represents a co-channel interference estimate as perceived by the MS.

Such a relative signal strength estimate allows for a FR/HR- exploitation criterion advantageous e.g. in case of sector cells with tight frequency reuse where co-channel interference is a main issue.

The estimating means may comprise:

estimating means for estimating the received signal strength. $SS_{ESTSERV}$. of a beacon channel signal from the currently serving BS, as received at the MS.

estimating means for estimating the received signal strength. $SS_{ESTNEIGHB}$. of a strongest neighboring beacon channel signal from a BS in a neighboring cell, as received at the MS.

calculating means for calculating the $SS_{ES}\tau$ as a function of said $SS_{ESTSERV}$ and SSHSTNEIGHB-

This provides for a straightforward realization exploiting existing BCCH-channels and measurement report schemes in GSM.

The calculating means may be arranged to calculate the SS_{EST} as said $SS_{ESTSERV}$-$SS_{ESTNEIGHB}$, the SS_{EST} thereby representing a co-channel interference estimate as perceived by the MS. This provides for a straightforward realization.

The node may be a base station controller. BSC, complying with the GSM standard wherein said traffic channel is a full rate. FR-, channel or a half rate. HR-, channel and wherein the updating of the user data bit rate is carried out by means of a intra-cell handover from a HR- or FR traffic channel to a FR- or HR traffic channel. This provides for a straightforward implementation exploiting existing GSM FR/HR channels and channel/measurement report schemes.

The allocated traffic channel may be an AMR coded HR- or FR traffic channel. This is an advantageous solution providing strong decrease of call drops still providing "increased" speech quality in the network.

Said means for blocking the dynamic updating of the user data bit rate of the allocated traffic channel if said $SS_{ES}\chi$ is below said T may be arranged to block the allocation of a HR-traffic channel to the MS if said $SS_{ES}\tau$ is below said T. This further decreases interference call drop rate since HR-channels may be allocated only to MSs near the serving BS and/or where received radio signal is not subject to high interference.

The node may further comprise:

means for establishing that a high traffic load threshold. T_{HL}- is exceeded,

traffic channel updating means arranged to reallocate a FR traffic channel from a FR channel to a HR channel for which FR channel the SS_{EST} is above T. when it is established that the T_{HL} is exceeded. This optimises the distribution of HR/FR allocation within the cell. decreases interference. call drop rate. and thus increases capacity.

T may be a signal strength threshold vector comprising a first threshold value. T_1. associated with FR to HR channel intra-cell handovers and a second threshold value, T_2, associated with HR to FR channel intra-cell handovers, wherein the T_2 value exceeds the T_1 value. and/or $T_{H1.}$ may be a threshold vector comprising a first threshold value, T_{HLI}. associated with FR to HR channel intra-cell handovers and a second threshold value, T_{HL2}, associated with HR to FR channel intra-cell handovers. wherein the T_{HL1} value exceeds the T_{HL2} value. In this way ping-pong situations may be avoided and/or the invention may provide a possibility that FR-channels will always be exploited at low traffic load and that HR-FR and FR-FR intra cell handovers are allowed at bad signal strength conditions. Many combinations are possible.

According to a second aspect. the invention provides a method to be used by a cellular radio network node comprising channel allocation and updating means for allocating a traffic channel to a mobile station. MS; the traffic channel having a suitable user data bit rate selected among a plurality of possible user data bit rates. and for dynamically updating the user data bit rate of such a traffic channel being allocated to the MS. the method comprising the steps of:

receiving. from a signal strength estimating means. an estimate of the received signal strength, SS_{EST}, of a channel as received at the MS. and

selecting the suitable user data bit rate as a function of said estimated signal strength. SS_{EST}.

The method may further comprise the steps of:

comparing said $SSE_{S}T$ with a predefined threshold value. T.

blocking the dynamic updating of the user data bit rate of the allocated traffic channel if said SS_{EST} is below said T.

The SS_{EST} mav˛ represent the received absolute signal strength. as received at the MS. for the traffic channel allocated to the MS. or for a beacon channel signal from the base station currently serving the MS, such as a BCCH-channel.

The $SSE_{S}T$ mav˛ ɩ)e a relative signal strength estimate between a channel received at the MS from a currently serving base station and a channel received at the MS from a neighboring base station. so that the $SS_{E}s\tau$ represents a co-channel interference estimate as perceived by the MS.

The method may comprise the steps of:

estimating the received signal strength, $SS_{EST}S_{ERV}$- of a beacon channel from the currently serving BS. as received at the MS.

estimating the received signal strength, $SS_{ES}TNEI_{G}HB$- of a strongest neighboring beacon channel from a BS in a neighboring cell, as received at the MS,

calculating the $SS_{E}s\tau$ as a function of said $SS_{ES}T_{S}ER_{V}$ and $SS_{E}S_{TNEIGHB}$ -

The SSEST may be calculated as said SSESTSERV-SSESTNEIGHB-

The step of estimating the received signal strength, $SS_{E}s\tau$ of a channel as received at a mobile station, MS, may comprise the steps of:

receiving a measurement report comprising $SSE_{S}T$ from the MS. and,

extracting the $SS_{E}s\tau$ value from the thus received measurement report.

This provides for an accurate estimate and straightforward implementation exploting existing (GSM) measurement report schemes.

The node may be a base station controller. BSC, complying with the GSM standard. wherein said traffic channel is a full rate. FR-, channel or a half rate. HR-, channel and wherein the updating of the user data bit rate is carried out by means of a intra-cell handover from a HR- or FR traffic channel to a FR- or HR traffic channel.

The allocated traffic channel may be an AMR coded HR- or FR traffic channel.

The method may further comprise the steps of:

comparing said $SS_{ES}\tau$ **with** a predefined threshold value. T.

blocking the allocation of a HR-traffic channel to the MS if said SS_{EST} is below said T.

The method may further comprise the steps of:

establishing a high traffic load threshold, $T_{HL>}$

updating a FR traffic channel from a FR channel into a HR channel for which FR channel the $SS_{ES}\tau$ is above T when it is established that the traffic load exceeds T_{HL}. This optimizes the distribution of HR/FR allocation within the cell. decreases interference. call drop rate, and thus increases capacity.

T may be a signal strength threshold vector comprising a first threshold value. $T_,$. associated with FR to HR channel intra-cell handovers, and a second threshold value, T_2, associated with HR to FR channel intra-cell handovers, wherein the T_2 value exceeds the Ti value.

According to a third aspect. the invention provides a computer program product comprising program code means which. when loaded into a processing means of a cellular radio network node or an execution node communicatively connected to a cellular network, make said processing means execute at least one procedure realizing the method according to the second aspect of the invention.

The computer program product may be realized in form of a computer readable medium having said program code means stored thereon.

Even though the invention has been summarized above. the invention is defined by the accompanying claims 1-25.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiments with reference to the accompanying drawings. wherein

FIG IA illustrates a cellular radio network 100 according to the invention.

FIG IB illustrates various means in one of the nodes illustrated in FIG IA.

FIG 2A-C together form (and being referred to as) FIG 2 and show a flow chart diagram illustrating the method according to the invention.

FIG 3A-M together form (and being referred to as) FIG 3 and illustrate the method according to the invention during use.

FIG 4A-B illustrate various cell areas as defined according to the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Now. with reference to FIG 1-4 the present invention shall be described in more detail.

The invention will here be described in detail for the specific embodiment wherein the cellular radio network is a GSM network, but it is to be understood that the invention is applicable for any cellular radio networks for which traffic channels have a suitable data bit rate chosen among a plurality of possible data bit rates and for which calls are being dropped because of a relative interference resistance of the signaling channels in comparison with the traffic channels. e.g. for 3GPP WCDMA networks.

Terminology:

HR: Half Rate or HR or GSM-HR is a speech encoding system for GSM developed in the early 1990s. Since the codec, normally operating at 5.6 kbit/s, requires half the bandwidth of the Full rate codec. network capacity for voice traffic is doubled, at the expense of audio quality.

FR: Full Rate or FR or GSM-FR is a speech encoding system for GSM developed in the early 1990s. The FR codec, normally operating at 11.2 kbit/s. requires double the bandwidth of the HR.

GSM DYMA (Dynamic Mode Adaptation) algorithm: conventional dynamic HR/FR- allocation algorithm in GSM.

AMR: Adaptive Multi-Rate is a conventional Audio data compression scheme optimized for speech coding. AMR is adopted as the standard speech codec by 3GPP.

T_{ABS}: Threshold for the absolute signal strength of the beacon signal/traffic channel of the serving base station as received by the MS. Normally measured in Watts or dBm.

T_{REL}: Threshold for the relative signal strength between the beacon/traffic channels of the serving base station and the "strongest" neighboring base station. as received by the MS. Normally measured in Watts or dB.

FIG IA illustrates schematically a GSM-cellular radio network 100 according to the invention. to which a mobile station. MS, 110 may establish a radio communication connection. The network 100 comprises a conventional Radio Base Station, RBS. 120 connected to a Base Station Controller node. BSC. 130 which in turn is connected to a conventional Mobile Switching Center node, MSC, 140. The BSC 130 comprises a suitable data processing unit or arithmetic logic unit 132. such as a CPU. communicatively coupled to a data memory 135. According to the invention, the data memory 135, which may be any suitable memory e.g. a RAM. comprises data program code means 136 which. when loaded into the CPU 132. makes the CPU 132 realize the method according to the invention as described further below. The data program code means 136 according to the invention may be stored on a data carrier, such as a CD-ROM 137. for the easy distribution/installation. Alternatively, the data program code means according to the invention may be stored and executed in/by a remote network server communicatively connected to the BSC 130. The method according to the invention is thus normally realized as a computer algorithm, the program code means 136 of which is stored in the memory 135. but other possibilities exist, e.g. pure hardware realizations.

FIG IB illustrates the main functional means which the invention, by means of said program code means 136 loaded into the CPU 132. provides in the BSC node 130. The BSC 130 comprises channel allocation- and updating means 150 arranged to receive signal strength estimate/s, SS_{EST}, from the means for estimating the received signal strength 160 of a channel as received at the MS 110. The channel allocation- and updating means 150 comprises comparing means 155 for comparing SS_{EST} with a threshold T and blocking means 152 for blocking the allocation of HR/FR channels and/or for blocking intra-cell FR/HR-HR/FR handovers. It further comprises reallocation means 153 for reallocating FR/HR channels into HR/FR channels, and conventional high load establishing means 151 for establishing a high traffic load condition in the cell, i.e. in the cell formed by the base station 120 currently serving the MS 110. The estimating means 160 for estimating received signal strength. SS_{EST}, of a channel as received at the MS comprises calculating means 170 being fed by conventional estimating means 161 for estimating received signal strength of a channel as received at the MS from the currently serving base station 120 and by conventional estimating means 162 for estimating received signal strength of a channel as received at the MS from a neighboring base station 125. The BSC 130 further comprises conventional receiving and extracting means 180 which are arranged to receive a measurement report from the MS which comprises SS_{EST} and being arranged to extract the SS_{EST} in a conventional manner. The receiving and extraction means 180 are arranged to forward the extracted SS_{EST} to either the estimating means 161 for estimating received signal strength of a channel as received at the MS from the currently serving base station 120 or to the estimating means 162 for estimating received signal strength of a channel as received at the MS from a neighboring base station 125 in a conventional manner, e.g. exploiting existing GSM measurement report schemes.

FIG 2 illustrates the method according to the invention. For the sake of clarity, the method will be described for the specific case where the invention is realised by modification of a conventional GSM-DYMA algorithm, but other possibilities exist. Conventional GSM-DYMA networks are commercially available e.g. from Ericsson$_{TM}$ AB. FIG 2 illustrates the case in which the method according to the invention is implemented on a connection basis, i.e. during and throughout an entire call, but other possibilities exist, e.g. to apply the HR/FR-FR/HR intra cell handover/exploitation control according to the invention only at call setup. In case the invention is applied at call set-up, the signal strength of the beacon signal, e.g. the BCCH-carrier, of the serving base station 120, as received at the MS 110, or the received signal strenght of the MS 110 as received at the RBS 120, is normally used as the received signal strength estimate, SS_{EST}, for controlling the HR/FR exploitation/intra-cell handover. Once a call is set up, i.e. a traffic channel is allocated to the MS, any of the traffic channel signal strength and the beacon signal strength, e.g. the BCCH carrier, of the serving base station may be used for controlling the FR/HR intra cell allocation/exploitation according to the invention. Normally, a signal strength estimate of the beacon signal of the serving base station is used. It is important according to the invention that an estimate of the actually received signal strength (absolute or relative) of said channel/s, as received by the MS, is used to control the exploitation of the FR/HR-channel exploitation rather than other channel quality estimates, such as e.g. BER, because BER values do not provide for an effective HR/FR-control, as explained above. Of course, the invention does not forbid the use of other channel quality estimates, such as BER as such, in addition to the pure "signal strength" HR/FR-exploitation criterion for additional criteria in order to optimize the overall radio network characteristics.

In step 201, the method according to the invention is activated/initiated by a triggering signal, which may be a manually (operator) controlled triggering signal e.g. from the MSC 140. In step 202, a traffic channel is allocated the MS 110, which may be a physical or hypothetical (i.e. simulated) traffic channel.

In step 210, the SS_{EST} is established/estimated for this allocated traffic channel associated with the MS 110. This may be carried out in different ways, e.g. by letting the MS 110 itself regularly measure the received signal strength in a conventional manner, i.e. the MS 110 measures the received power (Watts, dBm) during a time period on a received traffic/beacon channel, received from (at least) the serving base station. The MS 110 then reports this $SSes_T$-measure to the BSC 130 by transmitting conventional measurement reports to the RBS 120 over e.g. the SACCH (Slow Associated Control Channel), but many other possibilities exist. For instance, the signal from the MS 110 as received at the RBS 120 may be used as a measure of the path loss between the MS 110 and the serving RBS 120, and the path loss is indicative of SS_{EST}. In addition, the MS 110 may measure/establish the signal strength of the strongest neighbouring base station 125 in a conventional manner and SS_{EST} may then represent the relative signal strength between the beacon signals, e.g. BCCH-carrier-signals, from the serving base station and the strongest neighbouring base station. The relative signal strength estimate may be calculated e.g. as a relative dB value between said BCCH-carrier signals or by simply subtracting one BCCH-carrier signal from the other at the MS 110. The calculation may be carried out at the MS 110 or at the BSC 130. The MS 110 may transmit the estimated signal strength value to the BSC 130 in a conventional manner by means of a measurement report. Strongest neighbouring base station here means the base station 125 having the second strongest received beacon signal strength (after the serving base stations beacon) among a plurality of base stations neighbouring the serving base station 120, as received at the MS 110. This relative signal strength represents an effective fixed distance to cell boarder estimate, in terms of signal strength. T may according to one embodiment be a signal strength threshold vector comprising a first threshold value, Ti, associated with FR to HR channel intra-cell handovers and a second threshold value, T_2, associated with HR to FR channel intra-cell handovers, wherein the T_2 value exceeds the T_1 value. In this way ping-pong situations may be avoided.

In step 220 the SS_{EST} is compared with a (or alternatively a plurality of) predefined threshold value/s. T. If $SS_{ES}\tau$ exceeds T in step 220, then the method according to the invention proceeds to step 235 in which it is established whether the traffic load is high, i.e. above a threshold. T_{HL}- or not. T may be an absolute signal strength threshold, T_{ABS}, or a relative signal strength threshold. T_{REL} - If- in step 220, SS_{EST} is below (or equals) T. then the method according to the invention proceed directly to step 240.

If it is established in step 235 that the traffic load is high. i.e. that the traffic load exceeds a traffic load threshold. T_{HL}, the method according to the invention proceeds to step 237. otherwise directly to step 210. from step 235. In step 237. in case of a FR-allocated traffic channel to the MS. this FR traffic channel of the MS 110 is reallocated to a HR channel. The method proceeds from step 237 back to step 210. As a further possibility. the traffic load threshold, T_{1IL}. may be a vector comprising a first value. T_{HL1}, associated with FR-HR intra cell handovers. and a second value, T_{HL2}. associated with HR-FR imra-cell handovers. In this way the invention provides a possibility that FR-channels will always be exploited at low traffic load. Many combinations are possible.

In step 240, HR/FR-FR/HR intra-cell handovers for the MS 110 are all blocked. i.e. the MS 110 is not allowed to perform any intra-cell handover from a HR/FR traffic channel to a FR/HR traffic channel. This decreases the total call drop rate since drops related to the fact that the MS 110 is now in a relatively bad radio signal environment in which signalling necessary for such intra-cell handovers. over signalling channels (FACCH) which are likely not to be decoded at the BSC resulting in a high risk of drop of call. are now reduced. In this way fewer intra cell handovers will occur according to the invention. at least in a statistical sense. Furthermore. in case of AMR-coded traffic channels wherein the perceived (by human ear) quality of the traffic channel is relatively high even though the objective radio conditions may be bad. the invention will decrease the risk of call drop due to non decoded SACCH channel/s. Furthermore, as an option in step 240, a hypothetical (i.e. simulated) traffic channel for a new incoming call may be allocated a FR-channel (beacon used for simulating traffic channel signal strength). In this way the invention may restrict HR-exploitation to advantageous area/s within the cell. This may be carried out by moving a FR-call having a signal strength estimate exceeding T into a HR-channel. As an alternative in step 240. HR to FR and FR to FR intra cell handovers may be allowed. but no FR to HR intra cell handover, for the MS 110. The method then proceeds from step 240 back to step 210.

Now. referring to FIG 3A-M. the method according to the invention during use will be illustrated further by means of two illustrative examples.

Example 1 - Cell with increasing load

FIG 3A illustrates the traffic channels of a one TRX cell (with no BCCH or SDCCH and where T=-90 dBm, i.e. T represents an absolute single signal strength value not considering above ping-pong effects. for reasons of simplicity) and its behaviour as the traffic increases. As illustrated, initially it has 5 of its available timeslots occupied with traffic, each "busy" time slot associated with an estimated traffic channel signal strength, SS_{EST}- as measured for various MS-connections.

In FIG 3B, one more call comes in and at this stage no information is yet gathered regarding the $SS_{ES}\chi$ for this incoming call.

After some time lhe $SS_{E}s\tau$ JS established for this new call as described above and illustrated in FIG 3C.

After a while another call comes in as illustrated in FIG 3D. At this stage, the DYMA functionality detects "high load" as a traffic load threshold of one left timeslot (in this example) is met. According to the invention. the modified DYMA functionality of the invention now moves one FR call with sufficient SS_{EST} into a HR call. A HR BPC is created for this. This is illustrated in FIG 3E. The SS_{EST} for this new HR channel is not yet established, as illustrated in FIG 3F. The DYMA functionality still detects high traffic load as the high traffic threshold is still met and therefore another FR channel with sufficient SS_{Esr} is moved into the available HR space of the created HR BPC, as illustrated in FIG 3G. After a while the SS_{EST} of the first HR channel is established, as illustrated in FIG 3H. Then the $SS_{ES}\tau$ of the next HR channel is established, illustrated in FIG 31. The DYMA functionality according to the invention will neither move a connection with detected "low signal strenght". i.e. below T=90 dBm in this example, into a HR-channel. nor update a "low signal strength" HR-channel into a FR-channcl.

Example 2 - High loaded cell

FIG 3J describes a one TRX cell (with no BCCH or SDCCH and where T=-90 dBm. i.e. T represents an absolute single signal strength value not considering above ping-pong effects, for reasons of simplicity) and its behaviour when there is high traffic load. To start with it has 7 of its available timeslots occupied with traffic. The FR channels are according to the invention detected by the modified DYMA as low SS_{EST} FR channels and are therefore according to the invention not changed into HR channels. This represents a static condition of the algorithm. As a new call comes in the Dynamic Half-rate Allocation according to the invention estimates the traffic channel signal strength of a hypothetical traffic channel for this new incoming call as good, i.e. exceeding the threshold as explained above. and allocates the new call directly into a HR channel after changing the idle BPC into a HR BPC, as illustrated in FIG 3K. Later on, one of the half-rate subscribers ends his call. illustrated in FIG 3L. The half-rate packing part of DYMA detects "high traffic load" and packs the HR channels. as illustrated in FIG 3M.

FIG 4A and 4B illustrate how the SS_{EST} criterion according to the invention may restrict/control the HR/FR- or FR/HR exploitation/intra-cell handover. In FIG 4A, the serving base station 420 covers a first core area (white) in its immediate surroundings which is circumscribed by a second outer area (shaded). FIG 4A illustrates the case when a relative cell-to-cell threshold according to the invention may restrict the use of HR channels to the first cell core area only (the shape of the inner and the outer area are the same). If no neighbor cell exists in one direction (or in case of a mal-functioning neighboring cell) also an absolute signal strength threshold can be used to restrict the use of HR-channels. which is illustrated in FIG 4B. An absolute signal strength threshold would in ideal conditions, i.e. in case of a perfect unidirectional base station installed on completely plane ground and no scattering objects such as buildings etc. in the surroundings. give a circular inner area outside which HR-channels are not exploited and/or HR/FR-FR/HR intra-cell handovers are not permitted. FIG 4B illustrates the very same serving cell as in FIG

4A for which a neighboring cell "south-west" of the serving cell does not work, i.e. is malfunctioning and does not transmit any signals. The first cell core area in FIG 4B has been "enlarged" in the south-west direction by cooperation of the absolute signal strength and relative signal strength criteria according to the invention. This will ensure that not a too low signal strength connection is used for HR-channels e.g. in case of a malfunctioning neighbor cell.

The principles of the present invention have been described in the foregoing by examples of embodiments or modes/examples of operations, i.e. in the case of a GSM cellular radio system wherein a conventional DYMA algorithm has been modified. However, as already stated, the invention is applicable for any cellular radio network exploiting different user data bit rates and in which signaling channels are more interference/path loss sensitive than the traffic channels, e.g. it is applicable also for e.g. 3G (WCDMA) network/s. and a person skilled in the art realizes how to carry out the invention in such networks. For instance, in case of a 3G-WCDMA network, the algorithm according to the invention would normally be realized in a RNC (Radio Network Controller) node of the radio access network instead of the BSC as described above. Many combinations/modifications are possible, e.g. regarding various traffic channel quality combinations and load threshold criteria and the invention may be realized by means of several co-operating nodes instead of modifying a single network node, as described above. Furthermore, the order of the steps described above may be different than what is described above in certain cases, e.g. the traffic load criterion step described in step 235 may form a main criterion wherein the signal strength criterion described in step 220 becomes a sub-criterion, i.e. the user bit rate allocation then becomes a function of signal strength only when the traffic load exceeds a threshold, otherwise FR-channels are always allocated. Therefore, the invention should not be construed as being limited to the particular embodiments/working examples discussed above, and it should be appreciated that variations may be made in those embodiments/working examples by persons skilled in the art, without departing from the scope of the present invention as defined by the appended claims.

CLAIMS

1. A cellular radio network node (130) comprising:
- channel allocation and updating means (150) for allocating a traffic channel to a mobile station. MS (110); the traffic channel having a suitable user data bit rate selected among a plurality of possible user data bit rates, and for dynamically updating the user data bit rate of such a traffic channel being allocated to the MS (110),
characterised in that said channel allocation and updating means (150) is arranged for:
- receiving, from a signal strength estimating means (160). an estimate of the received signal strength, $SS_{ES}\tau$-of a channel as received at the MS (110). and
- selecting the suitable user data bit rate as a function of said estimated signal strength, SS_{EST}.

2. The node (130) according to claim 1 wherein the channel allocation and updating means (150) comprises:
- means (155) for comparing said $SS_{ES}\tau$ with a predefined threshold value, T.
- means (152) for blocking the dynamic updating of the user data bit rate of the allocated traffic channel if said SS_{EST} i^{s} below said T.

3. The node (130), according to claim 2 wherein the $SS_{E}s\tau$ represents an absolute received signal strength. as received at the MS (110), for a traffic channel allocated to the MS (110), or for a beacon channel signal from the base station currently serving the MS (110). such as a BCCH-channel.

4. The node (130) according to claim 2 wherein the SS_{EST} is a relative signal strength estimate between a channel received at the MS (110) from a currently serving base station (120) and a channel received at the MS (110) from a neighboring base station (125), so that the $SS_{E}s\tau$ represents a co-channel interference estimate as perceived by the MS (110).

5. The node (130) according to claim 3 or 4 wherein said estimating means (160) comprises:
- estimating means (161) for estimating the received signal strength, $SSE_{S}T_{S}ERV$- °f [a] beacon channel signal from the currently serving BS (120). as received at the MS (110),
- estimating means (162) for estimating the received signal strength. $SS_{EST}NEI_{G}HB$. of a strongest neighboring beacon channel signal from a BS (125) in a neighboring cell, as received at the MS (110).
- calculating means (170) for calculating the SS_{EST} as a function of said SSRSTSERV and $SS_{ES}TNEIGHB$.

6. The node (130) according to claim 5 wherein the calculating means (170) is arranged to calculate the $SS_{E}s\tau$ as said $SS_{ES}T_{SER}V$ - $SSE_{S}TNE_{I}G_{HB}$ - the $SS_{ES}\chi$ thereby representing a co-channel interference estimate as perceived by the MS (1lO).

7. The node (130), according to any of claims 1-6 being a base station controller, BSC (130). complying with the GSM standard wherein said traffic channel is a full rate. FR-, channel or a half rate, HR-, channel and wherein the updating of the user data bit rate is carried out by means of a intra-cell handover from a HR- or FR traffic channel to a FR- or HR traffic channel.

8. The node (130) according to claim 7 wherein the allocated traffic channel is an AMR coded HR- or FR traffic channel.

9. The node (130) according to claim 7 or 8 when read in conjunction with claim 2 wherein the means (152) for blocking the dynamic updating of the user data bit rate of the allocated traffic channel if said $SS_{ES}\tau$ is below said T is arranged to block the allocation of a HR-traffic channel to the MS (110) if said SS_{EST} is below said T.

10. The node (130) according any of claims 7-9 further comprising:
- means (151) for establishing that a high traffic load threshold, T_{HL}- is exceeded,
- traffic channel updating means (150) arranged to reallocate a FR traffic channel from a FR channel to a HR channel for which FR channel the SS_{EST} is above T. when it is established that the T_{HL} is exceeded.

11.The node (130) according to any of claims 10 wherein T is a threshold vector comprising a first threshold value. T_1. associated with FR to HR channel intra-cell handovers and a second threshold value, T_2. associated with HR to FR channel intra-cell handovers. wherein the T_2 value exceeds the T_1 value, and/or wherein T_{HL} is a threshold vector comprising a first threshold value. T_{HL1} associated with FR to HR channel intra-cell handovers and a second threshold value. T_{HL2}- associated with HR to FR channel intra-cell handovers, wherein the T_{HL1} value exceeds the T_{HL2} value.

12. A method to be used in a cellular radio network node (130) comprising channel allocation and updating means (150) for allocating a traffic channel to a mobile station. MS (110): the traffic channel having a suitable user data bit rate selected among a plurality of possible user data bit rates. and for dynamically updating the user data bit rate of such a traffic channel being allocated to the MS (110), the method comprising the steps of:
- receiving, from a signal strength estimating means (160), an estimate of the received signal strength. SS_{EST}- of a channel as received at the MS (110). and
- selecting the suitable user data bit rate as a function of said estimated signal strength. SS_{EST}-

13. The method according to claim 12 further comprising the steps of:
- comparing (220) said SS_{EST} with a predefined threshold value. T,
- blocking (240) the dynamic updating of the user data bit rate of the

allocated traffic channel if said SS_{Esr} is below said T.

14. The method according to claim 12 or 13 wherein the $SS_{ES}\tau$ represents the received absolute signal strength, as received at the MS (110), for the traffic channel allocated to the MS (110), or for a beacon channel signal from the base station currently serving the MS (110), such as a BCCH-channel.

15. The method according to claim 12 or 13 wherein the SS_{EST} is a relative signal strength estimate between a channel received at the MS (110) from a currently serving base station (120) and a channel received at the MS (110) from a neighboring base station (125), so that the $SS_{ES}\tau$ represents a co-channel interference estimate as perceived by the MS (110).

16. The method according to claim 15 further comprising the steps of:
- estimating the received signal strength, $SS_{ESTSERV}$, of a beacon channel from the currently serving BS (120), as received at the MS (110),
- estimating the received signal strength, $SS_{ESTNEIGHB}$, of a strongest neighboring beacon channel from a BS (125) in a neighboring cell, as received at the MS (110),
- calculating the SS_{EST} as a function of said $SS_{ESTSERV}$ and $SS_{ESTNEIGHB}$.

17. The method according to claim 16 wherein the $SS_{ES}\tau$ is calculated as said $SS_{ESTSERV} - SS_{EsTNEIGHB}$

18. The method according to any of claims 12-17 wherein the step of estimating (210) the received signal strength, SS_{EST} of a channel as received at a mobile station, MS, (110), comprises the steps of:
- receiving a measurement report comprising SS_{EST} from the MS (110), and,
- extracting the SS_{EST} value from the thus received measurement report.

19. The method according to any of claims 12-18 wherein the node (130) is a

base station controller, BSC (130), complying with the GSM standard, wherein said traffic channel is a full rate. FR-. channel or a half rate. HR-. channel and wherein the updating of the user data bit rate is carried out by means of a intra-cell handover from a HR- or FR traffic channel to a FR- or HR traffic channel.

20. The method according to claim 19 wherein the allocated traffic channel is an AMR coded HR- or FR traffic channel.

21. The method according to claim 20 or 2 1 further comprising the steps of:
- comparing (220) said $SS_{ES}\tau$ with a predefined threshold value, T.
- blocking (240) the allocation of a HR-traffic channel to the MS (110) if said SS_{EST} is below said T.

22. The method according to any of claims 19-21 further comprising the steps of:
- establishing a high traffic load threshold. $T_{HL>}$ (235),
- updating a FR traffic channel from a FR channel into a HR channel for which FR channel the $SS_{ES}\tau$ is above T when it is established that the traffic load exceeds T_{HL}.

23. The method according to any of claims 22 wherein T is a signal strength threshold vector comprising a first threshold value. T_1. associated with FR to HR channel intra-cell handovers. and a second threshold value, $T_{2,}$ associated with HR to FR channel intra-cell handovers. wherein the T_2 value exceeds the Ti value, and/or wherein T_{HL} is a traffic load threshold vector comprising a first threshold value, T_{HLI} - associated with FR to HR channel intra-cell handovers and a second threshold value, T_{HL2}, associated with HR to FR channel intra-cell handovers. wherein the T_{HLI} value exceeds the T_{HL2} value.

24. A computer program product (137) comprising program code means (136)

which, when loaded into a processing means (132) of a cellular radio network node (130) or of an execution node connected to a cellular network, make said processing means execute at least one procedure realizing the method according to any of claims 12-23.

25. A computer program product (137) according to claim 24 including a computer readable medium having said program code means (136') stored thereon.

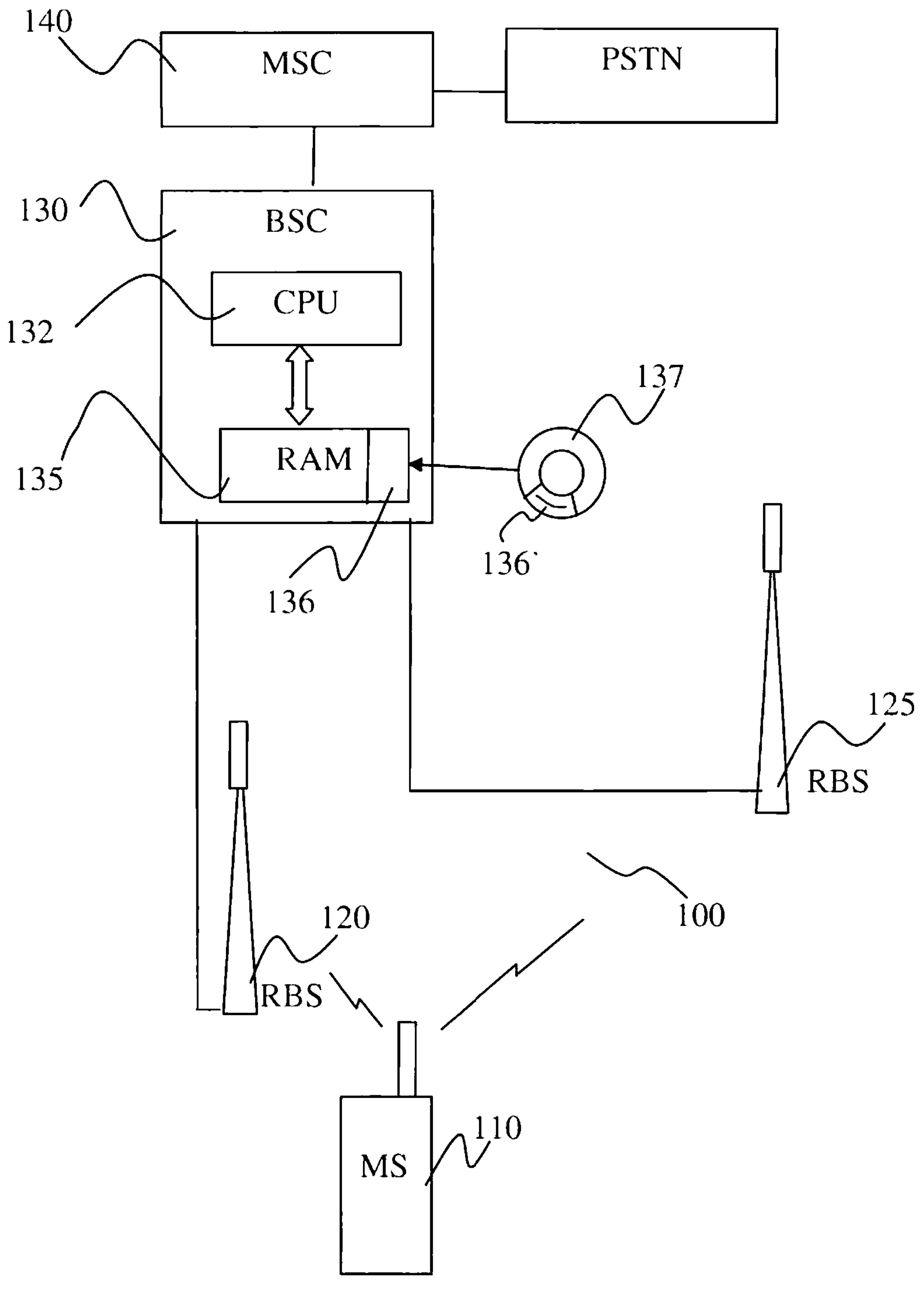

140
MSC
PSTN
130
BSC
CPU
132
137
135
RAM
136`
136
125
RBS
120
100
RBS
110
MS

FIG 1A

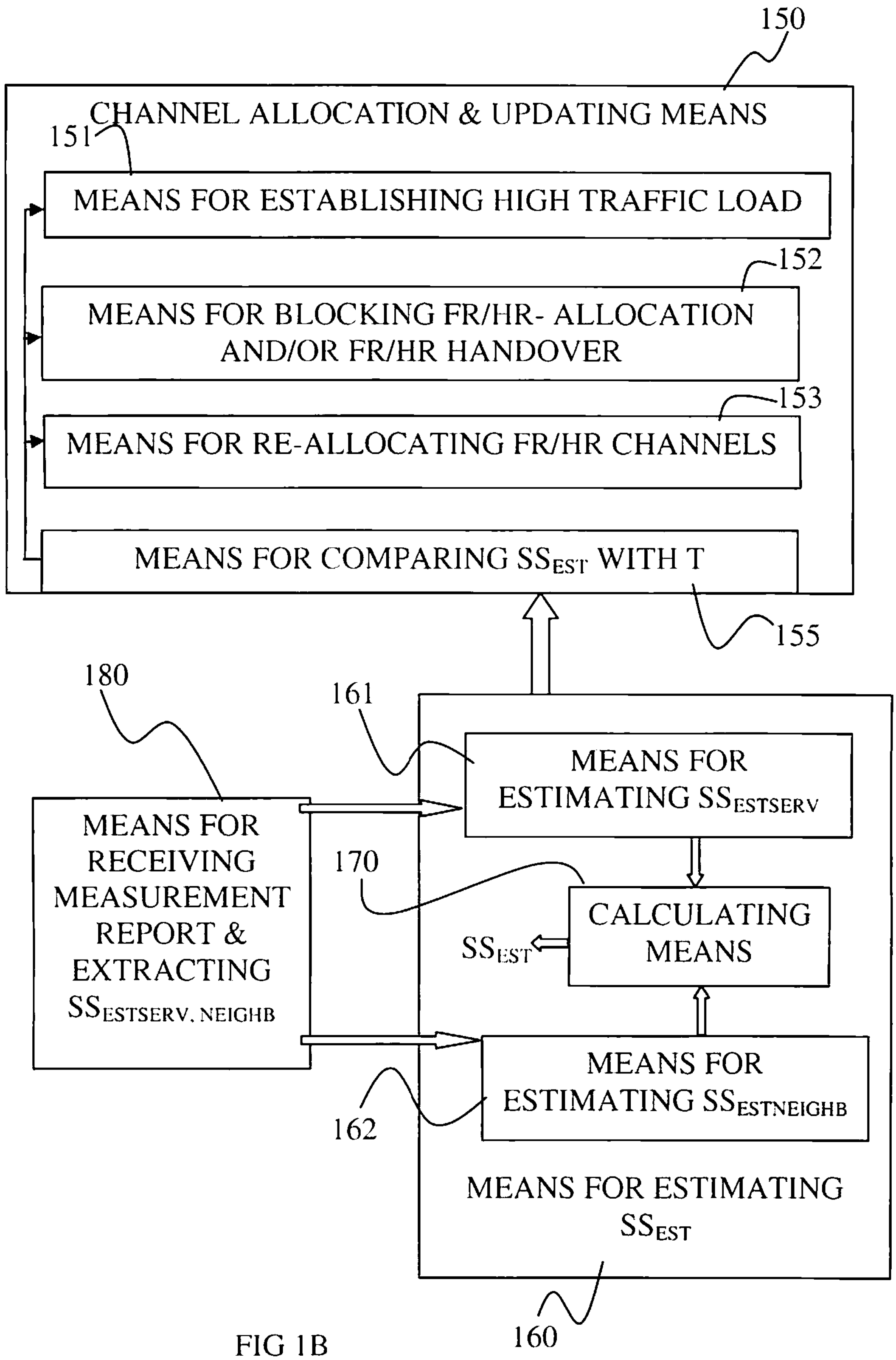

150
CHANNEL ALLOCATION & UPDATING MEANS
151
MEANS FOR ESTABLISHING HIGH TRAFFIC LOAD
152
MEANS FOR BLOCKING FR/HR- ALLOCATION AND/OR FR/HR HANDOVER
153
MEANS FOR RE-ALLOCATING FR/HR CHANNELS
MEANS FOR COMPARING SS_{EST} WITH T
155
180
161
MEANS FOR RECEIVING MEASUREMENT REPORT & EXTRACTING $SS_{ESTSERV,\ NEIGHB}$
MEANS FOR ESTIMATING $SS_{ESTSERV}$
170
CALCULATING MEANS
SS_{EST}
MEANS FOR ESTIMATING $SS_{ESTNEIGHB}$
162
MEANS FOR ESTIMATING SS_{EST}
160

FIG 1B

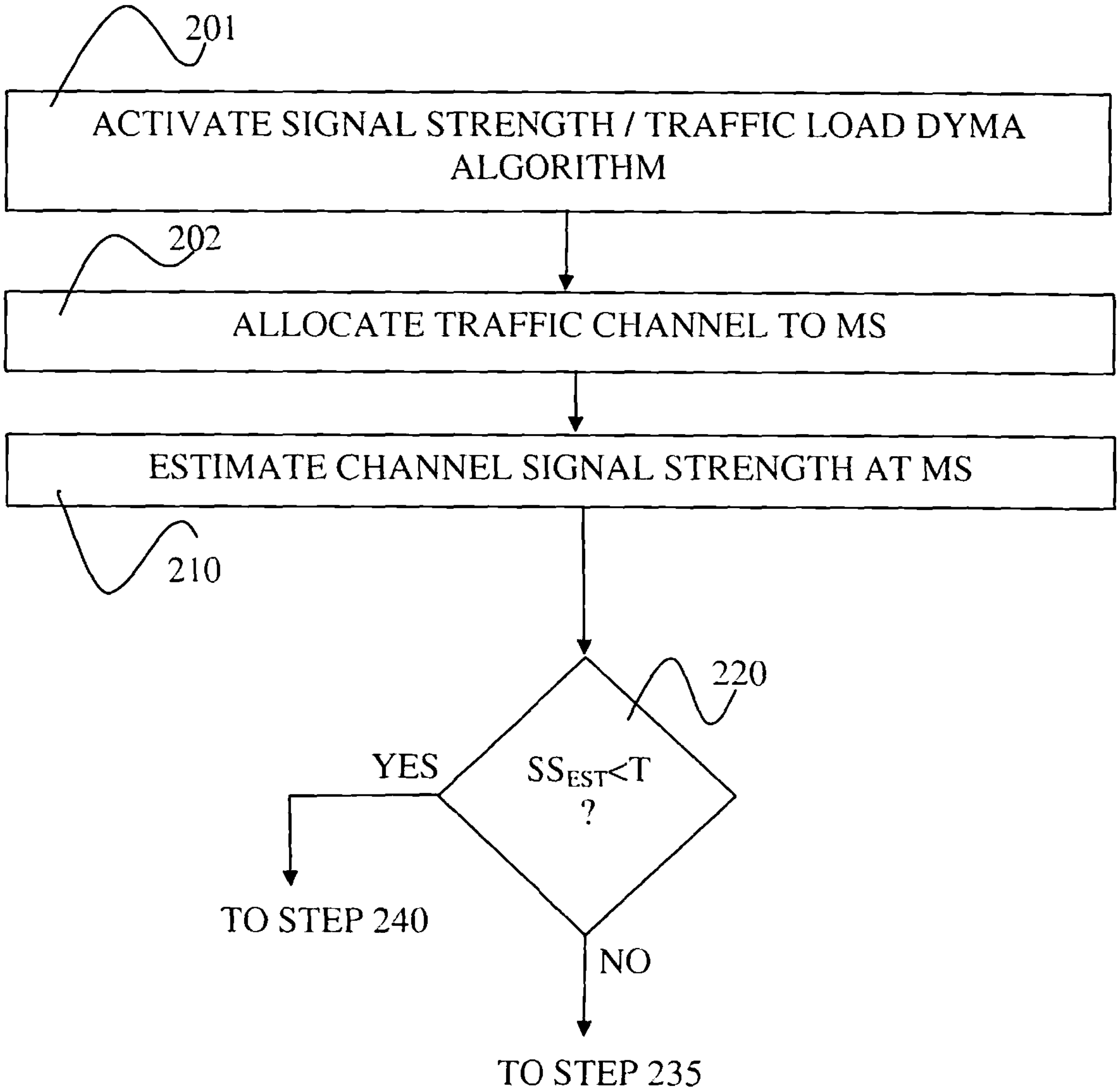

201
ACTIVATE SIGNAL STRENGTH / TRAFFIC LOAD DYMA ALGORITHM
202
ALLOCATE TRAFFIC CHANNEL TO MS
ESTIMATE CHANNEL SIGNAL STRENGTH AT MS
210
220
$SS_{EST}<T$?
YES
TO STEP 240
NO
TO STEP 235

FIG 2A

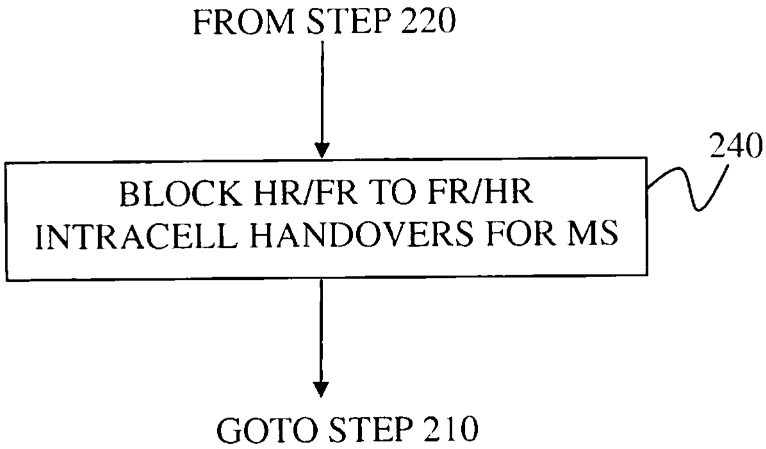

FROM STEP 220
240
BLOCK HR/FR TO FR/HR INTRACELL HANDOVERS FOR MS
GOTO STEP 210

FIG 2B

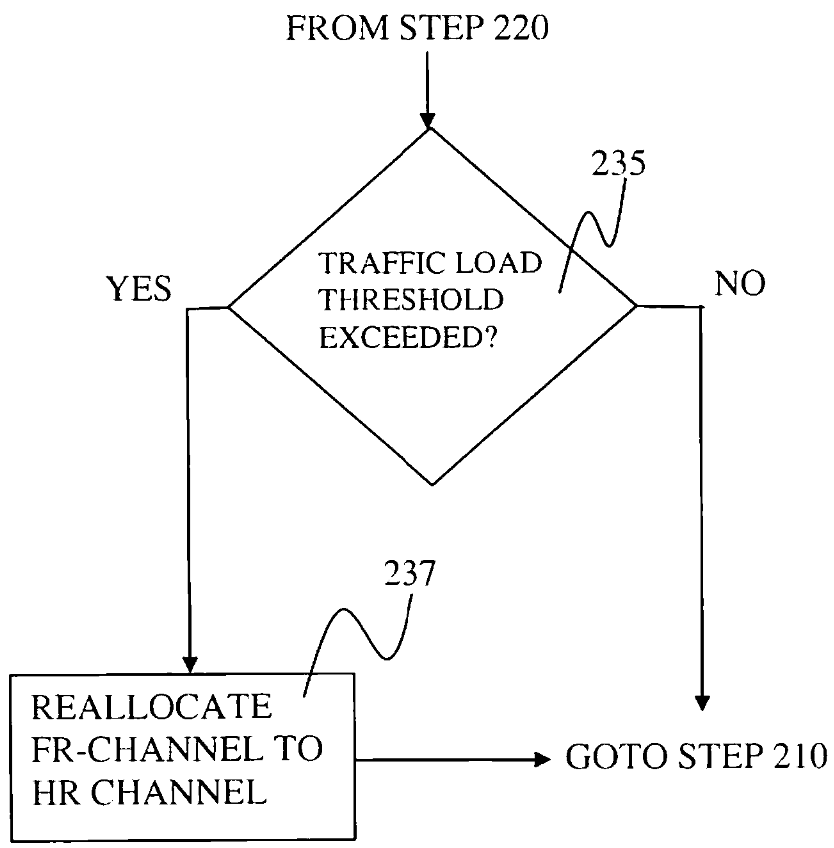

FROM STEP 220
235
TRAFFIC LOAD THRESHOLD EXCEEDED?
YES
NO
237
REALLOCATE FR-CHANNEL TO HR CHANNEL
GOTO STEP 210

FIG 2C

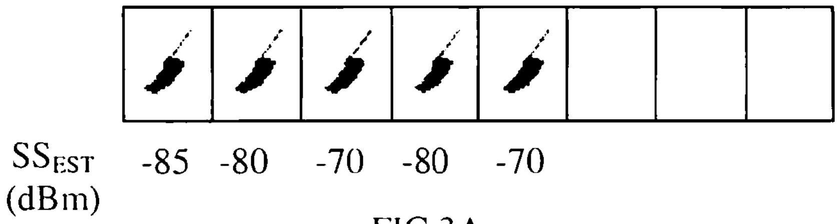


FIG 3A

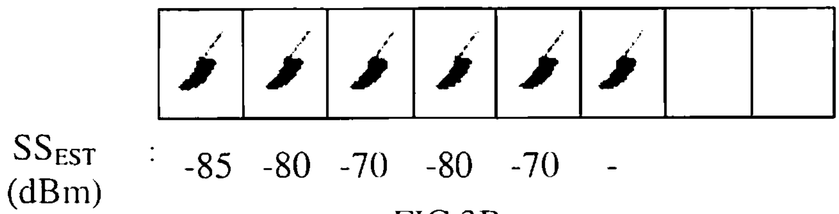


FIG 3B

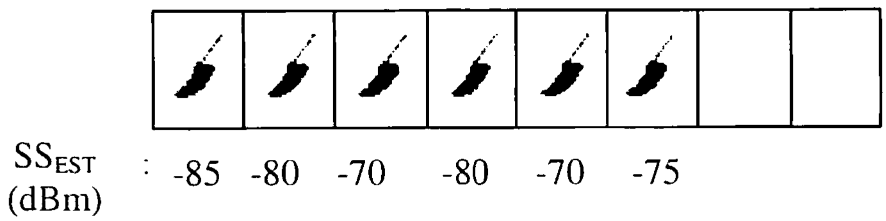


FIG 3C

FIG 3D

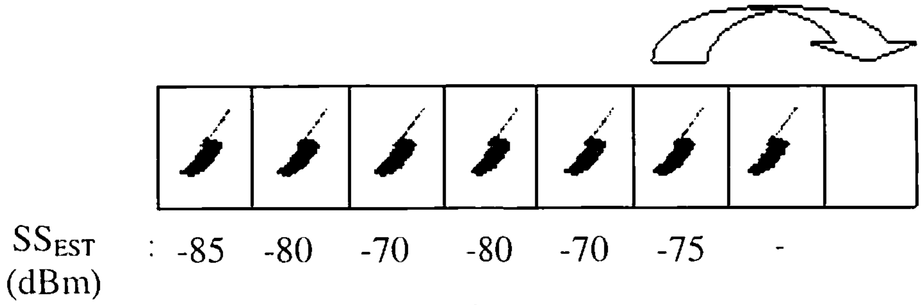


FIG 3E

FIG 3F

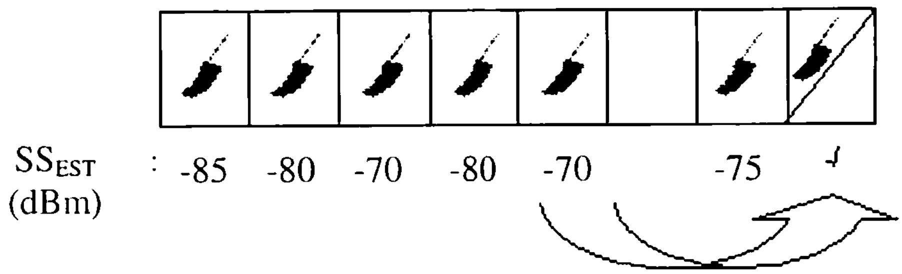


FIG 3G

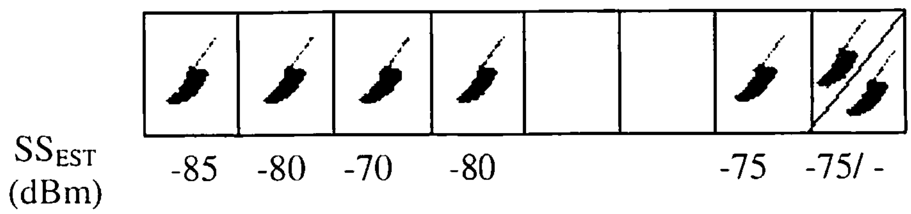
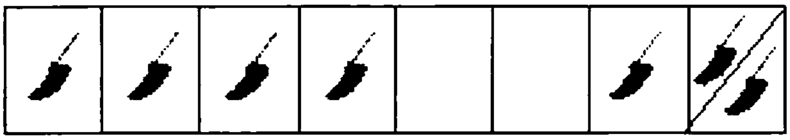
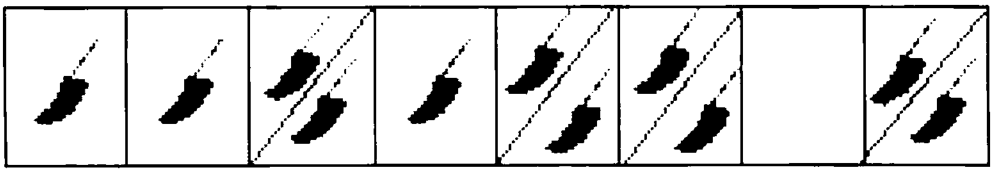


FIG 3H



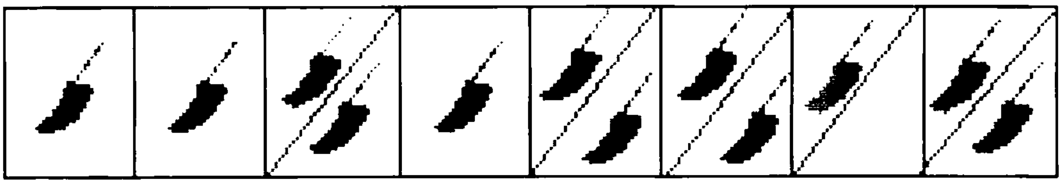
SS$_{EST}$ (dBm) : -85 -80 -70 -80 -75 -75/-70

FIG 3I



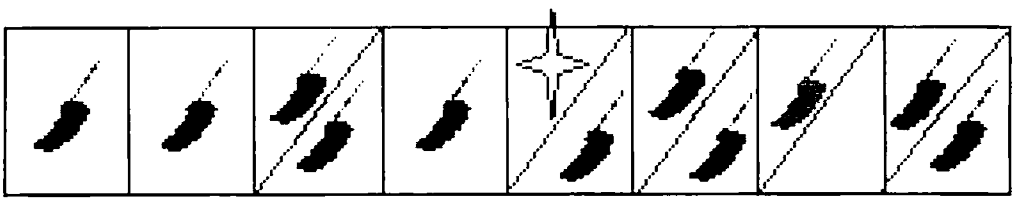
SS$_{EST}$ (dBm) : -100 -100 -70/-80 -100 -75/-70 -70/-70 -70/-75

FIG 3J



SS$_{EST}$ (dBm) -100 -100 -70/-80 -100 -75/-70 -70/-70 -70 -70/-75

FIG 3K



SS$_{EST}$ (dBm) : -100 -100 -70/-80 -100 -/-70 -70/-70 -70 -70/-75

FIG 3L

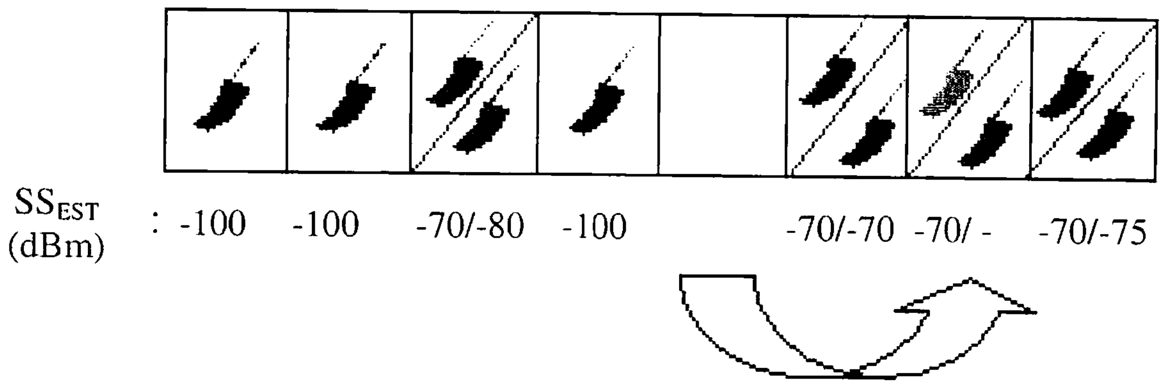


FIG 3M

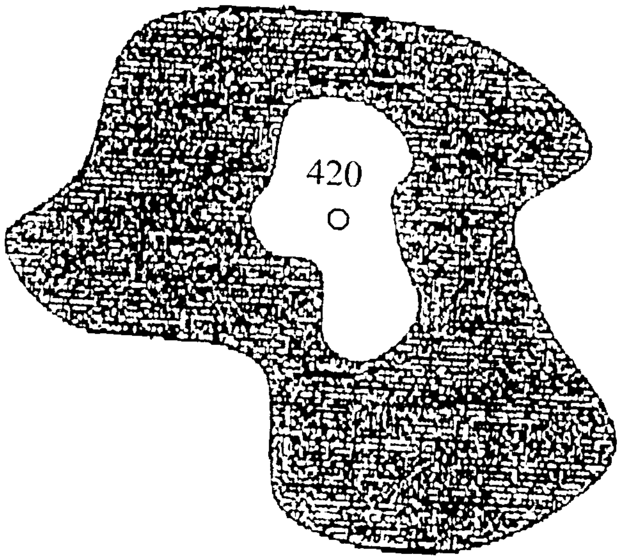


FIG 4A

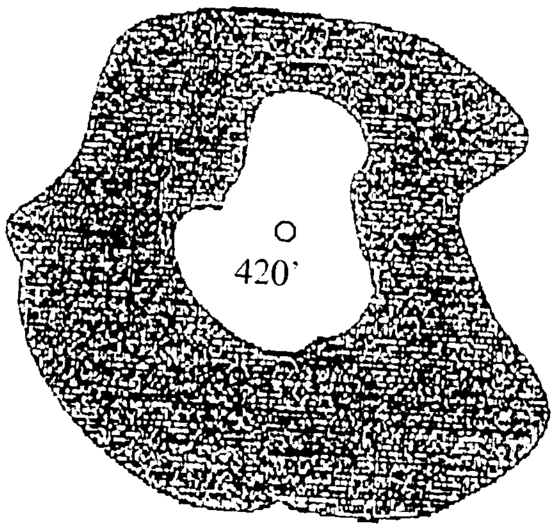


FIG 4B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2006/050052

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04Q, H04L, H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 20060046737 A1 (DOUGLAS, B ET AL), 2 March 2006 (02.03.2006), paragraphs [0005]-[0008]; [0080]-[0086]; [0102]-[0120], claims 6-11 --	1-25
X	US 20040203834 A1 (MAHANY, R L), 14 October 2004 (14.10.2004), paragraphs [0210]; [0355]-[0359] --	1-25
X	US 5706428 A (BOER, J ET AL), 6 January 1998 (06.01.1998), column 7, line 11 - column 8, line 29, figure 7 --	1-25

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
3 January 2007	12-01- 2007
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Elisabet Aselius /LR Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2006/050052

International patent classification (IPC)
H04Q 7/38 (2006.01)

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Use the application number as username.
The password is **MULGDDPAYZ** .

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85) .

Cited literature, if any, will be enclosed in paper form.

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