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(56) Documents Cited

**GB 2277233 A EP 0639929 A1 EP 0637895 A2
EP 0416872 A2 US 5343513 A US 4759051 A**

(58) Field of Search

**UK CL (Edition O) H4L LDSE LDSG LDSH
INT CL⁶ H04Q
Online:- WPI, INSPEC**

(54) Control system for cellular network

(57) A control system for a cellular radio network in which traffic capacity enhancing means such as micro cell structures and repeaters are selectively activated or de-activated in accordance with current traffic demands measured for example by call blocking rates in cells forming the network.

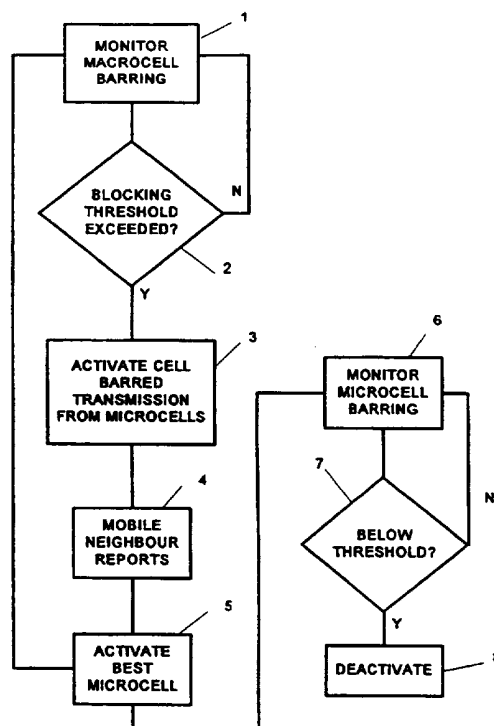


Fig. 2

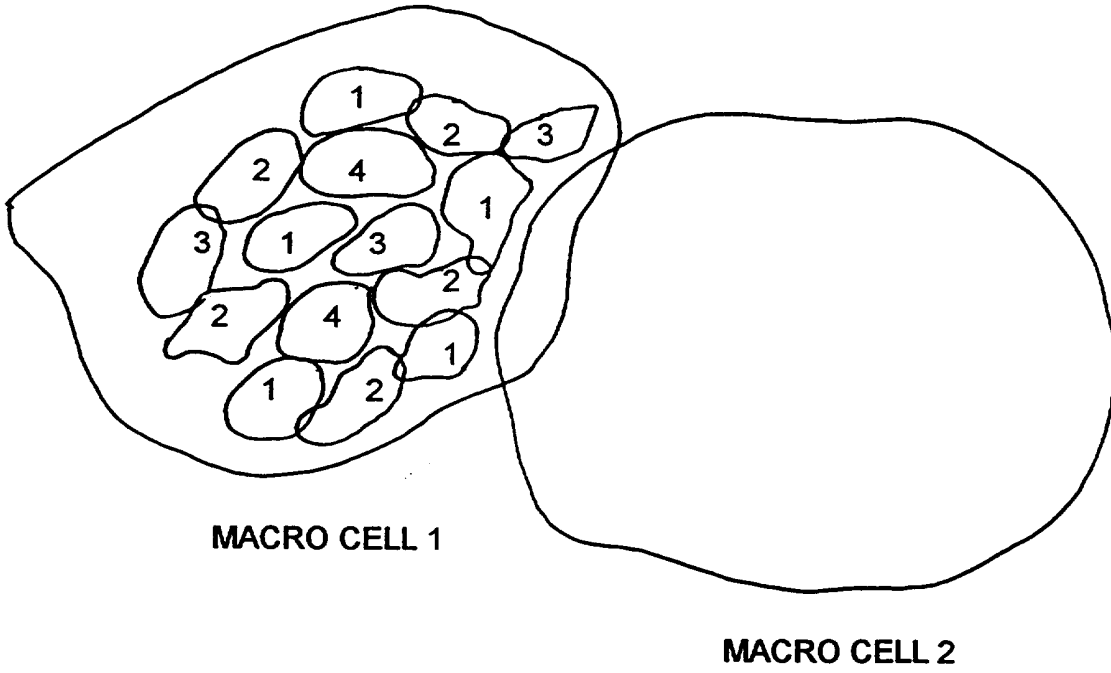


Fig. 1

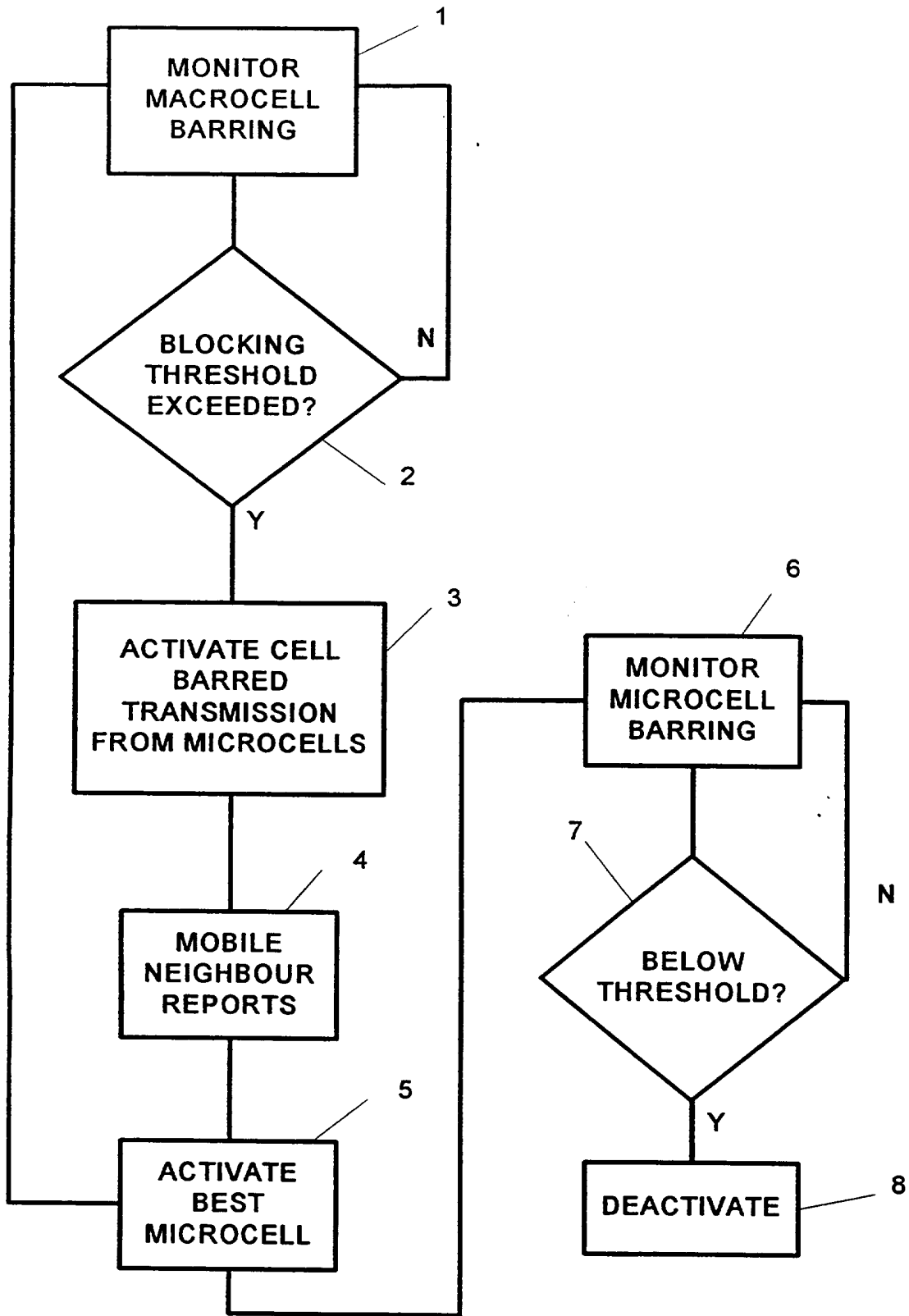


Fig. 2

CONTROL SYSTEM
FOR CELLULAR NETWORK

Field of the Invention

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This invention relates generally to cellular radio communication networks and more particularly to the control of cell availability and/or coverage in such a network.

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Background of the Invention

In a typical cellular radio system the area over which service is to be offered is divided into a number of smaller areas called cells, each of which is served from its own base station. Each cell has its own antenna or antennas for transmission to and reception from a user station, normally a mobile station. When a user station moves out of the area covered by one cell carrying a particular call the call is handed over to one of a number of neighbouring cells.

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The general principles governing the control of a typical network, operating under the GSM (Global System for Mobile Communications) protocol, are described in the publication entitled "European digital cellular communications system (Phase 2): Radio subsystem link control," GSM 05.08 version 4.9.0, dated 15 April 1994, by the European Telecommunications Standards Institute (ETSI).

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The capacity of a cell is determined by the number of channels, i.e. frequencies, available to the owner of the service. Since this number is limited, cell areas may be reduced to increase capacity since this permits available frequencies to be reused without intolerable interference being introduced into the network. Thus in rural areas where traffic density is low, cells tend to be large, while

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in urban areas traffic density tends to be higher requiring the use of smaller cells.

In addition, various capacity enhancing facilities may
5 be provided to improve the performance of a network according to capacity demands.

One example of such a facility is the provision, in selected cells, of an underlay of smaller cells, defined as
10 micro cells, serving small areas such as blocks within a district, with perhaps a further layer of still smaller cells, defined as pico cells, serving individual buildings or floors within a building. Such a structure is referred to as a hierarchical network.

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Another example of such a facility is the provision of repeaters for all channels or for selected channels used by a given cell.

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However demand for capacity is both time and location dependent. This raises the problem particularly in a hierarchical network that at certain times and in certain places the number of cells available may exceed requirements if the cell structure is created on the basis
25 of maximum demand. The problem is exacerbated when cells become smaller as the possibility of averaging high and low demand areas within a single cell is reduced. Moreover the risk of interference increases when more cells are active as does the chance that more handovers than
30 necessary will occur as mobile stations move within the network.

There is accordingly a need for an improved control system for a cellular network which enables capacity to be
35 more accurately matched to demand.

Summary of the Invention

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According to the invention there is provided a control system for a cellular radio network having one or more base stations each serving an associated cell, said base stations having capacity enhancing means for enhancing the traffic handling capacity of the associated cell, comprising capacity sensing means for sensing a need for extra capacity in the network, and control means responsive to said capacity sensing means to activate or de-activate said capacity enhancing means in a given cell depending on the need or otherwise for extra capacity in an area served by such cell.

The sensing means preferably identifies the need for extra capacity in the network by measuring the call blocking rate in a selected cell or cells.

For a hierarchical network traffic detecting means are preferably provided for detecting the level of traffic in the vicinity of a macro cell in the hierarchy and the control means may then be made responsive to both the capacity sensing means and the traffic detecting means to activate or de-activate a micro cell in the hierarchy.

There is further provided a method of controlling a cellular radio network having one or more base stations each serving an associated cell, said base stations having capacity enhancing means for enhancing the traffic handling capacity of the associated cell, comprising the steps of sensing a need for extra capacity in the network and activating or de-activating the capacity enhancing means in a given cell depending on the need or otherwise for extra capacity in an area served by such cell.

The need for extra capacity is preferably determined by measuring the call blocking rate in a cell or cells.

5 The traffic detecting means may use reports of traffic in neighbouring cells to provide an indication of traffic level.

10 The activation or de-activation of a selected micro cell may be by means of powering up/powering down or by establishing or breaking a connecting link to the said micro cell.

15 In order that the invention may be well understood a preferred embodiment thereof will now be described with reference to the accompanying drawings.

Brief Description of the Drawings

20 FIG.1. illustrates in simplified form a hierarchical cellular network

25 FIG.2. is a flow chart showing the implementation of the present invention in a hierarchical network of the type shown in FIG. 1.

30 Detailed Description of the Preferred Embodiment

FIG. 1. shows two overlay cells of a cellular network, referenced macro cell 1 and macro cell 2. Within macro cell 1 an underlay of micro cells is provided. The numbers within the micro cells represent the frequencies used by their respective base stations; in the example shown sixteen micro cells share four frequencies.

Conventionally a mobile station will select for communication the most suitable cell on the basis of radio criteria such as signal strength and/or network criteria such as the active or inactive status of designated cells.

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Circumstances can arise in which for a number of reasons, typically because the traffic handling capacity of a particular cell is limited and that the traffic currently being handled by the cell is close to the limit, a mobile station selecting a particular cell for communication will be refused access to that cell. This situation is referred to as call blocking. A system operating under the GSM protocol described above in which the present embodiment is implemented, conventionally develops a number of statistics for each base station to enable the proper management of the system. These statistics include a measure of the frequency of call blocking situations as described above together with further measurements such as the absolute volume of traffic currently being carried by a cell, call success rates, i.e. the proportion of calls maintained satisfactorily from initiation to completion, handover success rates, i.e. the proportion of attempted handovers to that cell which are successfully completed, and the number of dropped calls. In addition each base station has associated therewith a set of thresholds for each of the parameters measured in accordance with the particular characteristics of that site.

FIG.2. shows the additional facilities provided in a macro cell base station of a hierarchical network operating under the GSM protocol in order to perform the invention. While these facilities could be provided by a specific processor and associated logic, they are provided in the present embodiment by supplementary programme modules for the processing facilities already existing in the base station. The steps performed by these programme modules are shown in flowchart form in the figure.

Referring to FIG.2. at step 1 the call blocking activity in the macro cell is monitored as described above and the measurements are presented for comparison at step 2 with a predetermined blocking threshold. If the threshold is not exceeded the monitoring process continues. However if the threshold is exceeded the macro cell at step 3 causes those micro cells in its coverage area in cell barred state to transmit. These transmissions are monitored at 4 by mobile stations within the service area of the macro cell which at step 5 uses this information to determine which is the most appropriate cell to activate. The selected micro cell is activated and begins operation. Monitoring of the micro cell activity proceeds at step 6 until the micro cell traffic is found to have fallen at step 7 below a predetermined de-activation threshold at which point (step 8) the micro cell is de-activated. Should additional capacity be required by the macro cell after one additional micro cell has been activated steps 3, 4 and 5 may be arranged to cause further micro cells to be powered up until appropriate capacity is available as indicated by appropriate reduction in blocking rate.

In a system having capacity enhancing facilities in the form of repeaters each base station having such facilities may be provided with programme modules analogous to those shown in FIG.2. in order to activate or deactivate at steps 5 and 8 all or selected repeaters respectively to optimise the capacity of the cell or to enable capacity to be shared with an adjacent cell according to the traffic demands.

Further capacity adjusting techniques such as selective modification of the stored cell parameters and changes in transmitted power and frequency may also be made subject to the results of the tests performed in the embodiment described with reference to FIG.2.

CLAIMS

1. A control system for a cellular radio network
5 having one or more base stations each serving an associated
cell, said base stations having capacity enhancing means
for enhancing the traffic handling capacity of the
associated cell, comprising capacity sensing means (1,2)
for sensing a need for extra capacity in the network, and
10 control means (5) responsive to said capacity sensing means
to activate or de-activate said capacity enhancing means in
a given cell depending on the need or otherwise for extra
capacity in an area served by such cell.

15 2. A system as claimed in Claim 1 in which said
capacity sensing means is adapted to identify the need for
extra capacity in the network by measuring the call
blocking rate in a selected cell or cells.

20 3. A system as claimed in Claim 1 or Claim 2, for a
hierarchical network including traffic detecting means (4)
for detecting the level of traffic in the vicinity of a
macro cell in the hierarchy, said control means being
responsive to both the capacity sensing means and the
25 traffic detecting means to activate or de-activate a micro
cell in the hierarchy.

4. A system as claimed in Claim 3. in which said
detecting means is adapted to monitor traffic activity in
30 neighbouring cells to provide an indication of traffic
level.

5. A system as claimed in any preceding claim in
which the activation or de-activation of a selected micro
35 cell is effected respectively by powering up or powering
down.

6. A system as claimed in any of claims 1 to 4 in which the activation or de-activation of a selected micro cell is effected respectively by establishing or breaking a connecting link to the said micro cell.

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7. A system as claimed in any preceding claim in which said capacity enhancing means include repeaters and said control means is responsive to said capacity sensing means to activate or de-activate all or selected repeaters depending on the need or otherwise for extra capacity in an area served by a given cell.

8. A control system for a cellular radio network substantially as described with reference to the accompanying drawings.

9. A method of controlling a cellular radio network having one or more base stations each serving an associated cell, said base stations having capacity enhancing means for enhancing the traffic handling capacity of the associated cell, comprising sensing (2) a need for extra capacity in the network and activating (5) or de-activating (8) said capacity enhancing means in a given cell depending on the sensed need or otherwise for extra capacity in an area served by such cell.

10. A method as claimed in Claim 9 including the step of measuring the call blocking rate in a selected cell or cells to determine a need for extra capacity in said network.

11. A method as claimed in Claim 9 or Claim 10, for controlling a hierarchical cellular network, including the step of activating or de-activating micro cells within said network depending on the sensed need or otherwise for extra capacity.

12. A method as claimed in any of claims 8 to 11, for
controlling a cellular network including repeaters,
including the step of activating or de-activating all or
selected repeaters depending on the sensed need or
5 otherwise for extra capacity.

13. A method of controlling a cellular radio network,
substantially as described with reference to the
accompanying drawings.

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Claims searched: all

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Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.O): H4L (LDSH, LDSE, LDSG)

Int CI (Ed.6): H04Q

Other: Online:- WPI, INSPEC

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB2277233A Nokia - eg abstract	1,9
X	EP0639929A1 Siemens - eg WPI abstract	1,9
X	EP0637895A2 Motorola - eg abstract	1,9
X	EP0416872A2 Motorola - eg abstract	1,9
X	US5343513 Hughes Aircraft Co - eg abstract	1,9
X	US4759051 Hopeman & GB2203018A	1,7,9,12

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