

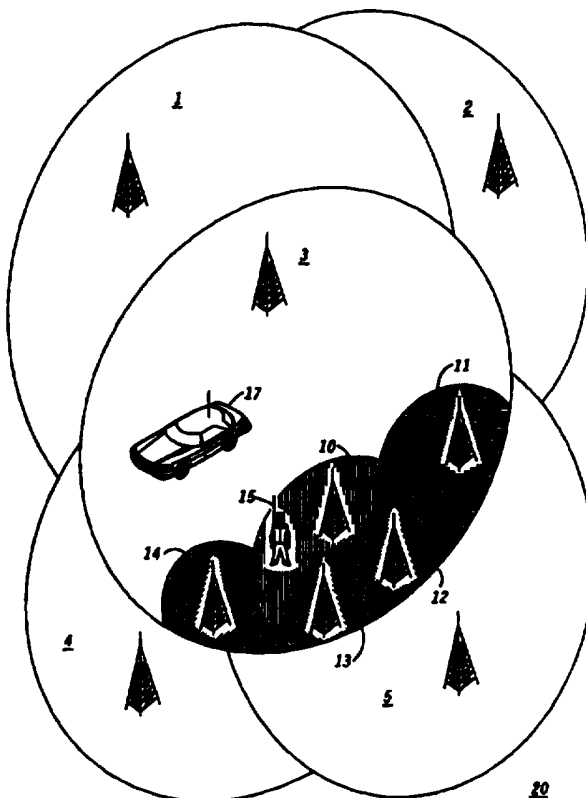
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H04Q 7/38, 7/22**A1****(11) International Publication Number: WO 96/05708****(43) International Publication Date: 22 February 1996 (22.02.96)****(21) International Application Number: PCT/EP95/03152****(22) International Filing Date: 9 August 1995 (09.08.95)****(30) Priority Data:**
9416167.6 10 August 1994 (10.08.94) GB**(71) Applicant (for all designated States except US):** MOTOROLA INC. [US/US]; 1303 Algonquin Road, Schaumburg, IL 60196 (US).**(72) Inventors; and****(75) Inventors/Applicants (for US only):** OBEROI, Rupinder, Singh [GB/GB]; 41 Keats Close, Wootton Bassett, Wilts SN4 8HH (GB). CRICHTON, Paul [GB/GB]; 3 Lonemead, Woolton Hill, Newbury, Berks RG15 9XY (GB). DAVIES, Robert, Ivor [GB/GB]; 26 The Mall, Old Town, Swindon, Wilts SW1 4JG (GB).**(74) Agents:** HIRSZ, Chris et al.; Motorola, European Intellectual Property Operations, Midpoint, Alencon Link, Basingstoke, Hampshire RG21 7PL (GB).**(81) Designated States:** AU, CA, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).**Published***With international search report.**Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.***(54) Title: COMMUNICATIONS SYSTEM AND METHOD FOR A MULTICELLULAR ENVIRONMENT****(57) Abstract**

A communications system as shown in the figure for a multicellular environment having an overlay location area wherein at least one macrocell is located within the overlay location area and a plurality of underlay location areas at least partially disposed within the overlay location area, each underlay location area having a number of microcells where the number of microcells in the underlay location area may be smaller than the number of macrocells in the overlay location area.

**25 OVERLAY LOCATION AREA**
27 UNDERLAY LOCATION AREA
28 UNDERLAY LOCATION AREA
29 UNDERLAY LOCATION AREA

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COMMUNICATIONS SYSTEM AND METHOD FOR A MULTICELLULAR
ENVIRONMENT

5

Field of the Invention

This invention relates in general to a communications system in a multicellular environment, and more particularly to a communications
10 system and a method for determining handover in a multicellular environment including an overlay and underlay of macrocells and microcells.

Background to the Invention

In a cellular communications system, a service coverage area by a
15 base station is called a cell. In a multicellular environment, a larger cell, or macrocell, may be further divided into smaller cells, or microcells in order to increase capacity. An overlay of macrocells may be implemented over the same area that an underlay of microcells are implemented. Thus, a microcellular network includes a plurality of microcells which may be
20 partially disposed within at least one macrocell. A mobile station may be located in an area that is serviced by both a macrocell and a microcell.

In digital cellular communications systems, such as the GSM (Global System for Mobile Communications), system objectives for a mobile station in idle mode in a microcellular network include during a cell selection
25 process, having mobile stations select a microcell in preference to a macrocell and during subsequent cell re-selection, having fast moving mobile stations camp on to macrocells and slow moving mobile stations stay on the microcellular network.

The first objective can be met by modification of path loss criterion
30 parameter C1 as defined in GSM recommendations.

In phase 2 of GSM a second parameter C2 is defined in the cell selection/reselection algorithm, which enables the phase 2 mobile station to camp on to right type of cell (microcell or macrocell) depending upon the speed of the mobile. This satisfies the second objective.

35 The parameter C2 is only defined as part of GSM phase 2 feature. Existing phase 1 mobiles do not implement this enhanced cell

selection/reselection algorithm and therefore cannot select the right sort of cell based on speed of the mobile.

There are currently a number of microcellular networks which will have a majority of phase 1 mobiles (no phase 2 mobiles are available at present). Therefore, it is essential that a process is defined which will enable current phase 1 mobiles to work efficiently in the microcellular network.

Currently there is no method for phase 1 mobiles to differentiate between microcells and macrocells depending upon speed of the mobile.

In the existing networks, due to existing installed base of phase 1 mobiles, it would be very difficult to of change the mobile software. However, there is scope to change the software in the infrastructure which will enable slow moving mobiles to remain on microcell and fast moving mobiles to be put on macro cells.

Thus, it is desired to have a communications system that includes a method in the base stations for determining handovers in a microcellular environment based upon the speed of the mobile station that will handover a fast moving mobile station to a macrocell and a slow moving mobile station to a microcell.

20

Summary of the Invention

According to the present invention, there is provided a communications system for a multicellular environment having at least one macrocell where partially disposed in the at least one macrocell is a plurality of microcells, each cell having a base station for communications with at least one mobile station, the communications system comprising an overlay location area wherein at least one macrocell is located within the overlay location area and a plurality of underlay location areas at least partially disposed within the overlay location area wherein at least one microcell is located in each underlay location.

In an alternative embodiment of the present invention a method is provided for planning a multicellular environment of at least one macrocell and a plurality of microcells wherein the microcells are at least partially disposed within a macrocell, including the steps of assigning a first number of macrocells to an overlay location area and assigning a second number of microcells to an underlay location area.

In a further embodiment method is provided for determining a handover for a mobile station in a multicellular environment having at least one overlay location area including at least one macrocell and a plurality of underlay location areas each underlay location area having at least one microcell, the underlay location areas are at least partially disposed within the overlay location area, each cell includes a base station, the method comprises the steps of measuring time between messages received at a base station for the mobile station and determining a handover in dependence upon the measured time.

Brief Description of the Drawing

FIG. 1 illustrates a multicellular environment according to the present invention.

FIG. 2 is a flow chart for a method for preferred embodiment of the present invention.

Detailed Description of the Preferred Embodiment

Referring to FIG. 1, a communications system 20 having a plurality of macrocells 1, 2, 3, 4, 5 where at least partially disposed in at least one macrocell 3 is a plurality of microcells 10, 11, 12, 13, 14. Each macrocell and microcell has a respective base station for communications with at least one mobile station. A fast moving mobile station 17 is shown being serviced by a macrocell 3 and a slow moving mobile station 15 is shown being serviced by a microcell 10.

The multicellular communications systems 20 of FIG. 1 further includes an overlay of at least one location area 25 that comprises a number of macrocells 1, 2, 3, 4, 5 that are located within the location area 25 and shown by right to left diagonal shading across macrocells 1, 2, 3, 4, 5.

A plurality of underlay location areas 27, 28, 29 are shown disposed within the overlay location area 25 and particularly disposed within a macrocell 3, each underlay location area 27, 28, 29 comprises at least one microcell. Thus, there is a topology of at least one overlay location area 25 comprising of macrocells 1, 2, 3, 4, 5 and underlay location areas 27, 28, 29 comprising of microcells 10, 11, 12, 13, 14.

Particularly, underlay location area 27 comprises of one microcell 11 and is shown in FIG. 1 by horizontal shading. Underlay location area 28 comprises of two microcells 12, 13 and is shown by left to right diagonal

shading. Underlay location area 29 comprises of two microcells 10, 14 and is shown by vertical shading. The number of microcells that are included in an underlay location area may be smaller than then the number of macrocells included in an overlay location area. The minimum number of microcells
5 that are included within an underlay location area is one. The smaller number of microcells in an underlay location area allow for detecting more location update requests for a fast moving mobile station.

Thus, a method of planning a multicellular environment having overlay and underlay location areas according to an embodiment of the
10 present invention includes assigning a first number of macrocells to an overlay location area and assigning a second number of microcells to an underlay location area where the second number may be smaller than the first number.

Referring to FIG. 2 a flow chart is shown for a method of determining
15 a handover for a mobile station in a multicellular environment as described above including the steps of measuring time between a message received at a base station for the mobile station and determining a handover in dependence upon the measured time. In a preferred embodiment of the present invention the message is a location update request also known as
20 LU REQ in GSM specifications.

At some point in the planning of the topological networks including the overlay and underlay location areas as described above there must be some assigning of a first number of macrocells to an overlay location area and a second number of microcells to a first underlay location area and a
25 third number of microcells to a second underlay location area where the second number and the third number may be smaller than the first number. There is also a determination or an identification of which location area or type of location area that the mobile station is located within. For example, whether the mobile station is being serviced by the microcellular network
30 and thus in an underlay location area or being serviced by the macrocellular network and in an overlay location area.

The flow chart of FIG. 2 shows, according to a preferred embodiment of the present invention, that when a mobile station is powered up and in normal idle mode operation as in step 101, it waits until a location update
35 (LU) is requested. For example, in normal idle operation, step 101, when a mobile crosses a location area and there is a better cell in that area, it will camp on to that cell and request a location update.

If a location update is requested as in step 102, the infrastructure will analyse the request. If it is determined that the request is not a location update from a microcell to another microcell, then the normal update procedure is followed as in step 106 (and as defined in GSM specifications).

5 If the infrastructure determines that the location update is from a microcell to a microcell, then the time between the last location update request is determined by the base station 103. If it is the first location update request then the base station stores the time and waits until the next location update request to determine time between requests. Similarly, a
10 rate of time may be determined between requests as well as over a number of requests to get an average rate. The location update rate is determined with respect to time. Thus, time may be measured between location updates to get a location update rate.

15 If the time between location update requests is above a predetermined threshold as decided in 104, then the mobile station is handed over to a macrocell as in step 105.

If the time is below a predetermined threshold as decided in step 104, then the mobile follows the normal location update procedures.

20 The process to force the mobile station on to the macrocell can be achieved in several ways. One possible implementation is as follows:

1) Mobile send LU request for next microcell.

2) Infrastructure determines that the mobile needs to be handed over to the macrocell network.

3) Infrastructure sends LU accept for the microcell.

25 4) The infrastructure forces the mobile to handover to macrocell cell network using normal handover procedures.

30 The present invention defines a process in a base station or BSS which enables slow moving mobiles to stay on the microcellular network, whilst fast moving mobiles are put on the macrocellular network. It uses rate or time between location update requests (within microcells) from a mobile station to indicate the speed of the mobile. Mobile stations requesting location updates often are deemed to be moving quickly and are moved to an available macrocell. Mobile stations requesting location updates less often are kept on microcells.

35 It is also important that the C1 settings and the RF planning ensures that microcells are stronger candidate cells than macrocells. The invention proposes that there is an underlay/overlay of location areas assigned. The

macrocell location areas maybe created as normal, with for example 20 cells per location area. The microcellular network will have fewer cells per location area. The minimum number will be typically one cell per location area in densely populated urban areas.

5 The signalling traffic will not be significantly affected by this microcell location area topology as the invention works to move mobile stations with high location update rates on to macrocells. Thus, it is likely that the location update rate will not be significantly higher than that of a standard network.

10 The cell reselect hysteresis for location areas needs to be made high for the macrocells so that once a mobile has moved on to the macrocell it is difficult to move back on to the microcell. Mobile stations are encouraged on to microcells by the favourable signal levels and C1 settings. If they are moving quickly they will be moved to macrocells by the network and held
15 there by the process of cell reselect hysteresis.

 This invention enables operators of existing GSM phase one networks to increase the capacity of the network by adding a microcell underlay network. The operation of the existing infra-structure and phase 1 mobiles is unaffected. The present invention offers an opportunity to build a
20 network underneath an existing network GSM digital cellular network and efficiently use valuable spectrum allocation. The present invention provides a method of efficiently planning and implementing handovers for mobile stations in such multicellular environments.

Claims

1. A communications system for a multicellular environment having at least one macrocell where at least partially disposed in the at least one macrocell
5 is a plurality of microcells, each cell having a base station for communications with at least one mobile station, the communications system comprising:
 - an overlay location area wherein at least one macrocell is located within the overlay location area; and
 - 10 a plurality of underlay location areas at least partially disposed within the overlay location area wherein at least one microcell is located within each underlay location area.
2. The communications system of claim 1 wherein the number of microcells
15 in each underlay location area is smaller than the number of macrocells in the overlay location area.
3. A method of planning a multicellular environment of at least one macrocell and a plurality of microcells wherein the plurality of microcells are
20 at least partially disposed within the at least one macrocell, the method comprising the steps of:
 - assigning a first number of macrocells to an overlay location area; and
 - assigning a second number of microcells to an underlay location area.
- 25 4. The method of claim 3 wherein the second number is smaller than the first number.
5. A method of determining a handover for a mobile station in a multicellular environment having at least one overlay location area
30 including at least one macrocell and a plurality of underlay location areas each underlay location area having at least one microcell, the underlay location areas are at least partially disposed within the overlay location area, each cell includes a base station, the method comprising the steps of:
 - measuring time between messages received at a base station for the
35 mobile station; and
 - determining a handover in dependence upon the measured time.

6. The method of claim 5 wherein the message is a location update request.

7. A method of determining a handover for a mobile station in a multicellular environment including an overlay of at least one macrocell and an underlay of a plurality of microcells wherein the underlay is at least partially disposed within the overlay, the method comprising the steps of:

5 assigning a first number of macrocells to an overlay location area;
assigning a second number of microcells to a first underlay location area and a third number of microcells to a second underlay location area;

10 determining whether the mobile station is in the underlay location areas;
measuring a time between location update requests for the mobile station in the base station; and
determining a handover in dependence upon whether the mobile

15 station is in the underlay location areas and the measured time between location update requests.

8. The method of claim 7 wherein the second number and the third number are smaller than the first number

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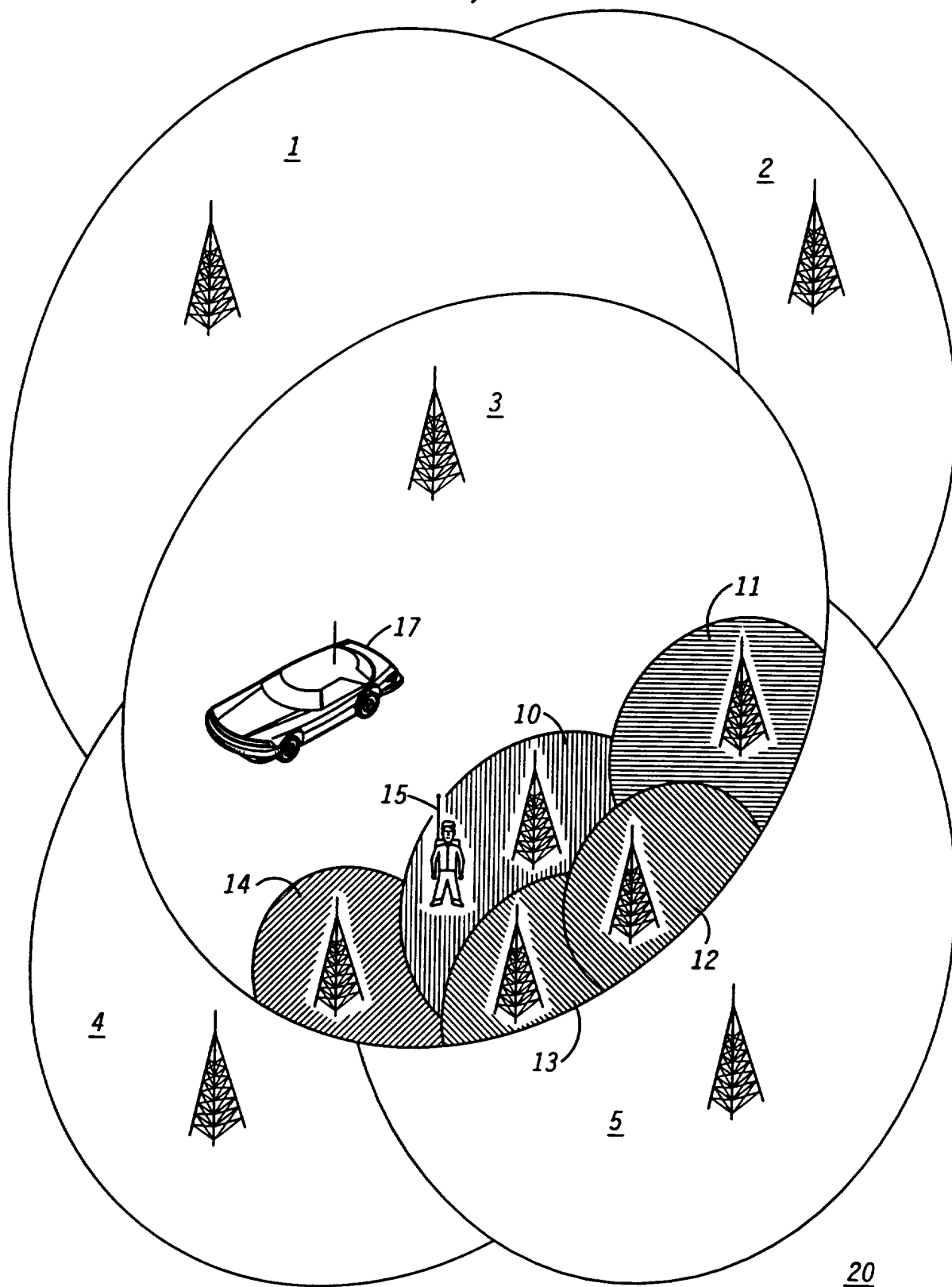


FIG. 1

25	OVERLAY	LOCATION	AREA	
27	UNDERLAY	LOCATION	AREA	
28	UNDERLAY	LOCATION	AREA	
29	UNDERLAY	LOCATION	AREA	

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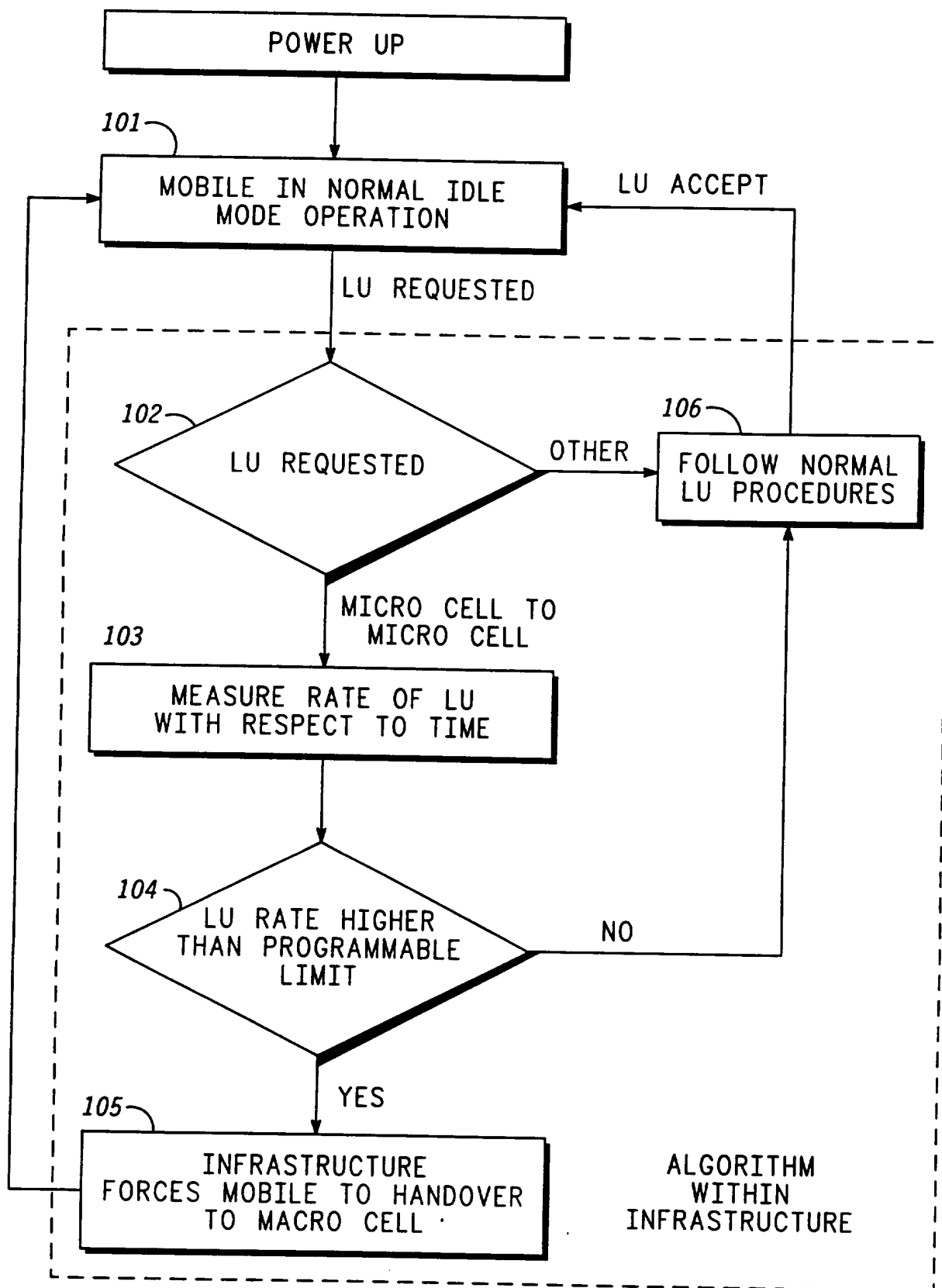


FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No
PC1/EP 95/03152

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q7/38 H04Q7/22

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 6 H04Q

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 016 no. 354 (E-1242) ,30 July 1992 & JP,A,04 111700 (NIPPON TELEGR & TELEPH CORP) 13 April 1992, see abstract	1,3
Y	---	5,7
X	EP,A,0 505 106 (VODAFONE LTD) 23 September 1992 see column 1, line 23 - line 43 see column 2, line 53 - column 3, line 8 see column 3, line 31 - column 4, line 3 see column 4, line 10 - line 27 see column 4, line 34 - line 42 ---	1,3
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☒ Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search

8 December 1995

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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP,A,0 589 278 (SIEMENS AG) 30 March 1994 see column 3, line 11 - line 55 see column 4, line 11 - line 26 see column 4, line 32 - column 5, line 9 see column 8, line 8 - line 33 see claim 1 ---	1,3,5,7
Y,P	EP,A,0 660 635 (NIPPON ELECTRIC CO) 28 June 1995 see column 2, line 46 - line 55 see column 6, line 3 - column 8, line 55 -----	5,7

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 95/03152

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		NO-A- 933362	24-03-94
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