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(12) (19) (CA) **Demande-Application**

(21) (A1) **2,276,155**
(86) 1997/12/23
(87) 1998/07/09

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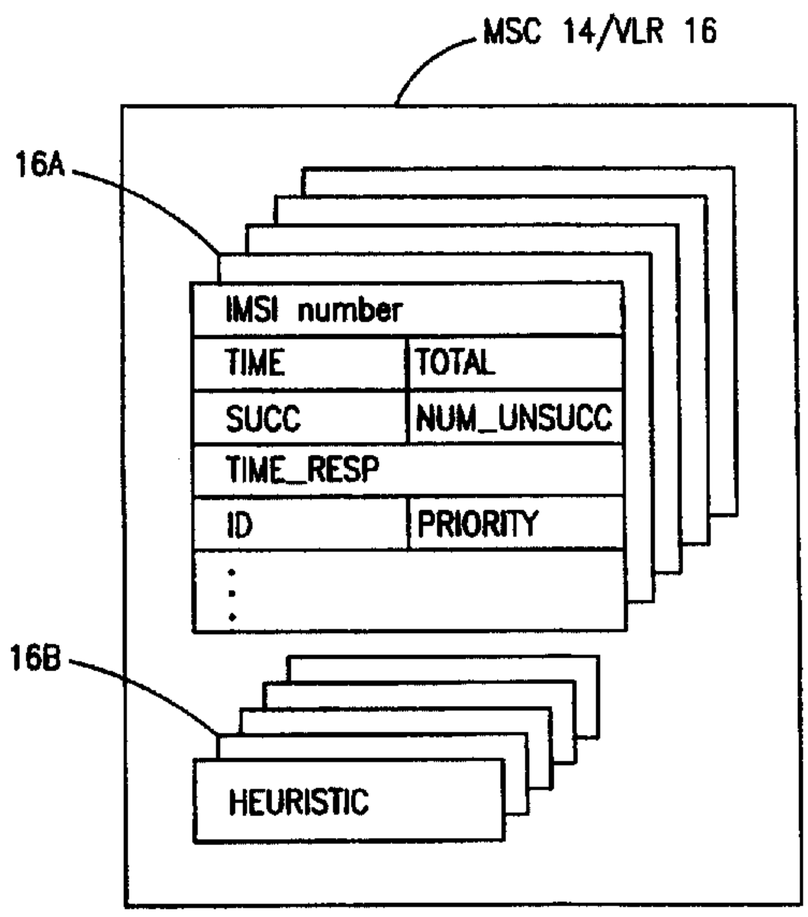
(51) Int.Cl.[6] H04Q 7/38
(30) 1996/12/30 (08/775,444) US

(54) **GESTION SPECIALE DE RADIOMESSAGERIE A REPETITION**
(54) **SPECIAL HANDLING OF REPEATED PAGING**



(57) Cette invention concerne un système et un procédé permettant de commander le nombre et la portée des appels de personne adressés à un abonné mobile dans un système de télécommunications sans fil. Des informations fonctionnelles, relatives à chacun des abonnés, sont stockées au sein du centre de commutation mobile/enregistreur de localisation de visiteurs respectif, associé à chaque abonné, et les appels de personnes destinés à l'abonné sont modifiés en vertu d'une règle donnée, stockée dans une base de données de règles, conformément aux informations fonctionnelles.

(57) A system and method for controlling the number and scope of pages to a mobile subscriber in a wireless telecommunications system is disclosed. Operational information about each subscriber is stored within the respective Mobile Switching Center/Visitor Location Register for that subscriber, and pages to the subscriber are modified pursuant to a given rule stored in a rules database in accordance with the operational information.

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
H04Q 7/38

A3

(11) International Publication Number: WO 98/30046

(43) International Publication Date: 9 July 1998 (09.07.98)

(21) International Application Number: PCT/US97/23530

(22) International Filing Date: 23 December 1997 (23.12.97)

(30) Priority Data:
08/775,444 30 December 1996 (30.12.96) US

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(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

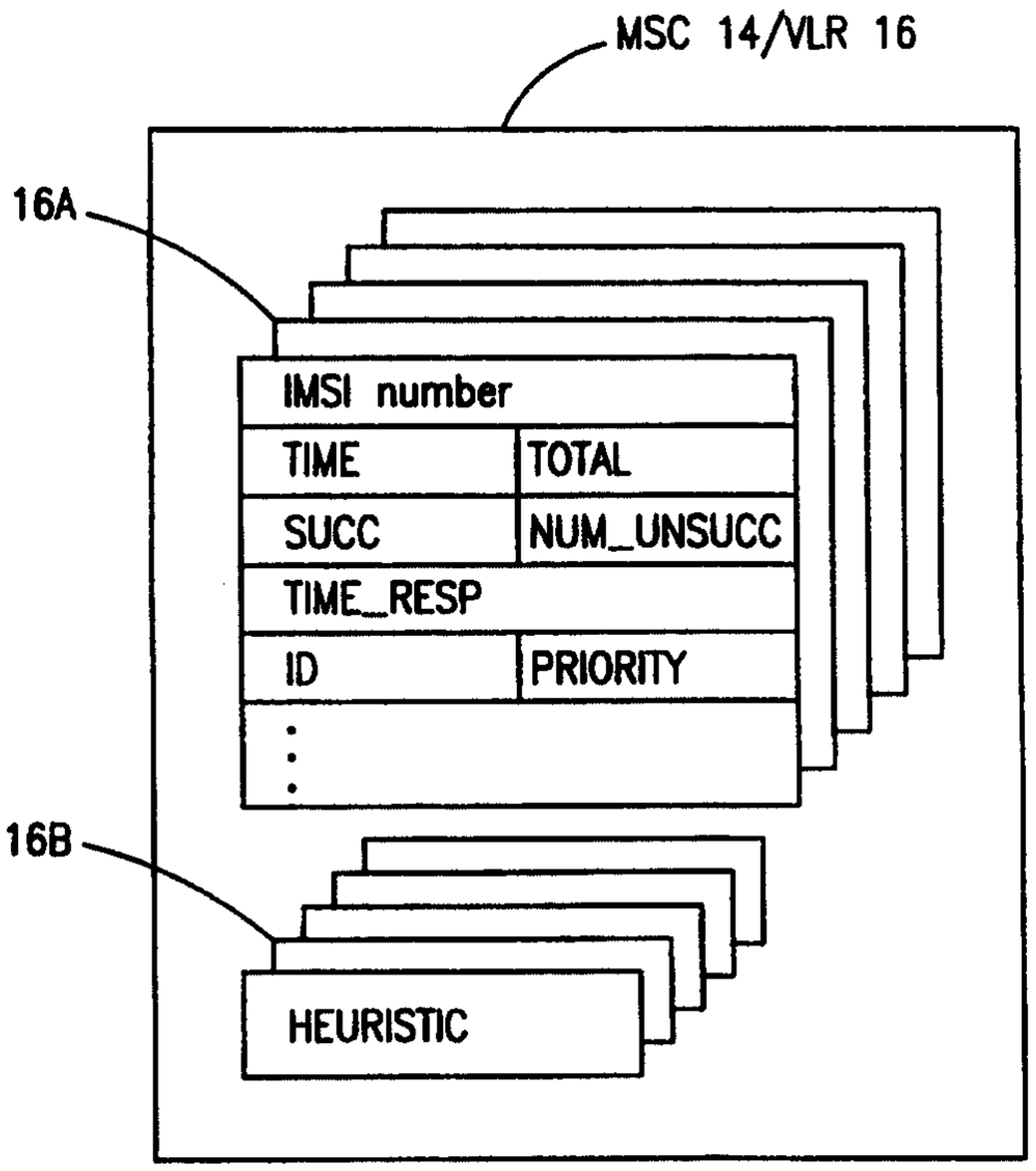
Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(88) Date of publication of the international search report:
22 October 1998 (22.10.98)

(54) Title: SPECIAL HANDLING OF REPEATED PAGING

(57) Abstract

A system and method for controlling the number and scope of pages to a mobile subscriber in a wireless telecommunications system is disclosed. Operational information about each subscriber is stored within the respective Mobile Switching Center/Visitor Location Register for that subscriber, and pages to the subscriber are modified pursuant to a given rule stored in a rules database in accordance with the operational information.



SPECIAL HANDLING OF REPEATED PAGING

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to a telecommunications system and method for improved paging, particularly, to a telecommunications system and method for improving paging through use of paging history characteristics associated with each mobile subscriber in the telecommunications system.

Background and Objects of the Present Invention

The evolution of wireless communication over the past century, since Guglielmo Marconi's 1897 demonstration of radio's ability to provide continuous contact with ships sailing the English Channel, has been remarkable. Since Marconi's discovery, new wireline and wireless communication methods, services and standards have been adopted by people throughout the world. This evolution has been accelerating, particularly over the last ten years, during which the mobile radio communications industry has grown by orders of magnitude, fueled by numerous technological advances that have made portable radio equipment smaller, cheaper and more reliable. The exponential growth of mobile telephony will continue to rise in the coming decades as well, as this wireless network interacts with and eventually overtakes the existing wireline networks.

Within every wireless telecommunication system there are paging channels used to page or contact mobile stations within the system, e.g., a car cellular phone, which listens for paging signals. With the increasing use of cellular and other wireless communications, the number of new mobile subscribers and cellular phones in operation has rapidly increased. Since there are usually few paging channels available in a given wireless or cellular telecommunications system, it is clear that conservation

of this limited system resource is important to preserve adequate paging capability and prevent excessive communication delays.

One such delay occurs where a mobile subscriber in a given telecommunications system has roamed out of their local area of coverage. Pages to that localized area will then, of course, be unsuccessful, and the system consequently expands the scope of the page to include neighboring areas in an effort to reach the mobile subscriber. However, long delays may occur as successive and widening pages are performed, and the caller may think that the call has been dropped and prematurely terminate the call. Accordingly, such paging not only consumes valuable system resources but may also lead to customer dissatisfaction. A general overview of location management procedures is discussed in IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, Vol. 44, No. 3, August 1995.

It is, therefore, an object of the present invention to modify wireless systems to ameliorate or overcome the aforedescribed paging problems and decrease customer dissatisfaction.

It is an additional object of the present invention to decrease the number of pages necessary to contact mobile subscribers within wireless systems.

It is also an object of the present invention to decrease the number of pages by flexibly adjusting the paging protocol of the telecommunications system to accommodate the individual characteristics of the users therein.

It is a further object of the present invention to decrease the number of mobile subscriber pages by tracking various paging history characteristics pertaining to the particular mobile subscribers in the system and adjusting the paging protocol in accordance with those characteristics.

SUMMARY OF THE INVENTION

The present invention is directed to a system and method for controlling the number and scope of pages to

a mobile subscriber in a wireless telecommunications system. Paging information about each subscriber is stored within the respective Mobile Switching Center/Visitor Location Register for that subscriber, and pages to the subscriber are modified in accordance with the paging information.

A more complete appreciation of the present invention and the scope thereof can be obtained from the accompanying drawings which are briefly summarized below, the following detailed description of the presently-preferred embodiments of the invention, and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a schematic diagram of a conventional cellular network system;

FIGURE 2 is a schematic diagram further illustrating the cellular network shown in FIGURE 1;

FIGURE 3 is a schematic diagram further illustrating the portion of the cellular network shown in FIGURE 2; and

FIGURE 4 is a block diagram of a Mobile Switching Center/Visitor Location Register in accordance with the present invention.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

With reference to FIGURE 1 of the drawings, there is illustrated a Public Land Mobile Network (PLMN), such as cellular network 10, which in turn is composed of a

plurality of areas 12, each with a Mobile Switching Center (MSC) 14 and an integrated Visitor Location Register (VLR) 16 therein. The MSC/VLR areas 12, in turn, include a plurality of Location Areas (LA) 18, which is defined as that part of a given MSC/VLR area 12 in which a mobile station (MS) 20 may move freely without having to send update location information to the MSC/VLR area 12 that controls that LA 18. Each Location Area 18 is divided into a number of cells 22. Mobile Station 20 is the physical equipment, e.g., a car phone or other portable phone, used by mobile subscribers to communicate with the cellular network 10. A Base Station (BS) 24 is the physical equipment, illustrated for simplicity as a radio tower, that provides radio coverage to the geographical area of the cell 22 in which to handle radio traffic to and from the MS 20.

With further reference to FIGURE 1, the PLMN Service Area or cellular network 10 includes a Home Location Register (HLR) 26, which is a database maintaining all subscriber information, e.g., user profiles, current location and routing information, International Mobile Subscriber Identity (IMSI) numbers, and other administrative information. The HLR 26 may be co-located with a given MSC 14 or service one or more separate MSCs 14, the latter of which is illustrated in FIGURE 1. IMSI is a unique 15-digit identification number assigned to each mobile station 20, and includes a Mobile Country Code (MCC) of three digits, a Mobile Network Code (MNC) of two (or three) digits, and a Mobile Subscriber Identification Number (MSIN), the latter two constituting a National Mobile Subscriber Identity (NMSI) number.

The VLR 16 is a database containing information about all of the mobile stations 20 currently located within the MSC/VLR area 12. If a mobile station 20 roams into a new MSC/VLR area 12, the VLR 16 connected to that MSC 14 will request data about that mobile station 20 from the HLR database 26 (simultaneously informing the HLR 26 about the

current location of the mobile station 20). Accordingly, if the user of the mobile station 20 then wants to make a call, the local VLR 16 will have the requisite identification information without having to reinterrogate the HLR 26.

With reference to FIGURE 2, there is shown another view of the PLMN Service Area 10, illustrating an MSC 14 and integrated VLR 16 for one of the aforedescribed MSC/VLR areas 12, which contain Location Areas 18a-18f, respectively, therein. As discussed, a particular MS 20 may roam within a particular LA 18 without forwarding update data. Accordingly, a mobile subscriber, who last used their MS 20 in a particular LA 18, e.g., LA 18a, will be paged there first. As is understood in the art and discussed further in connection with FIGURE 3, the mobile network in looking for said particular MS 20 of said mobile subscriber may page them throughout the entire LA 18a, i.e., in all of the cells 22 therein, or a subset thereof. In this manner, the mobile subscriber, whose MS 20 is preferably in an active state, may readily communicate and respond to a paging communication.

With reference now to FIGURE 3, each Location Area 18 within the coverage area of the particular MSC 14/VLR 16 is, as described and illustrated in connection with FIGURE 1, subdivided into a multiplicity of cells 22, shown as cells 22a-f in FIGURE 3. It should, of course, be understood that each cell 22, being within a respective LA 18, is served by the same MSC 14/VLR 16 of that respective LA 18. It should also be understood that the serving mobile network may identify a particular radio coverage area for a given cell 22 using a Cell Global Identity (CGI). Different cells 22 within a given LA 18 may be distinguished using a Cell Identity and Base Station Identity Code (BSIC) assigned to each serving base station, as is understood to those skilled in this art.

Conventional paging techniques page a mobile subscriber within the aforedescribed cellular network 10

locally first, with subsequent broader pages until the mobile subscriber responds or an allotted time to make the connection expires. With reference again to FIGURE 3, the initial "local" page is usually within one Location Area, e.g., within the highlighted LA 18f as illustrated in the figure. It should be understood, however, that the initial page may be more narrow and instead be within one of the particular cells 22a-22f therein. If the mobile subscriber fails to respond to the local page within LA 18f, then a "global" page is performed throughout all of the Location Areas 18 serviced by that MSC 14/VLR 16, i.e., LAs 18a-f.

Conventional paging protocols typically follow this local then global procedure without variation, regardless of the demands on system resources and regardless of the prior actions of the mobile subscriber. For example, where recent page attempts to a given mobile subscriber have failed, i.e., the subscriber has not responded within the local or even global paging areas, additional local pages shortly thereafter are unlikely to succeed. Thus, skipping the local paging step for this subscriber and instead proceeding to first globally page that subscriber would be a more efficient use of system resources. The caller would also benefit since they would experience less delay in either communicating with the subscriber or receiving an indication of failure. As an extra benefit for the caller, additional time may be allocated for the global page in such instances.

Accordingly, through modifications to the MSC 14/VLR 16 servicing a given mobile subscriber, these and other advantages of the present invention are achieved. More particularly, the paging protocol set forth hereinafter, instead of following the rigid routine of conventional systems, is flexible and adaptable to the circumstances surrounding the given mobile subscriber, as will be described in more detail hereinafter.

Shown in FIGURE 4 is a representation of the VLR 16 illustrated in the previous figures including therein a multiplicity of subscriber operational data records 16A for a corresponding multiplicity of mobile subscribers in contact with the MSC 14/VLR 16 in question. The respective subscriber data records 16A contain information about the respective mobile subscriber's paging history, i.e., information about the particular circumstances of that subscriber's paging.

The paging history information stored in the respective data records 16A may include some or all of the following illustrative examples:

1. Time of the last page attempt (TIME).
2. Total number of page attempts within a particular most recent or last time interval (TOTAL).
3. Success of last page (SUCC).
4. Response time of successful page (TIME_RESP).
5. Number of unsuccessful page attempts for last page within said particular most recent or last time interval (NUM_UNSUCC).
6. Last known cell identification where mobile subscriber made contact with network (ID).

All or some of the above operational data may be stored within respective fields within the data records 16A. Preferably, each data record 16A within the VLR 16 has an identifier, e.g., a pointer, uniquely identifying the particular mobile subscriber. Such identifier thus preferably contains at least the unique International Mobile Station Identification (IMSI) number for the subscriber, as illustrated. It should, of course, be understood that alternative identification schemes may be useful in this situation. It should also be understood that the time variables, TIME and TIME_RESP, indicate a standard time reference, SUCC is a Boolean flag, and TOTAL, NUM_UNSUCC and ID are preferably integers. All of the aforedescribed field variables and any additional or

alternate field variables may be stored in a conventional manner within the respective fields of the respective data records 16A.

Also stored within the VLR 16 is a heuristic or rules database 16B used to make decisions based upon the information stored within the aforedescribed data records 16A. It should be understood that either or both of the operational data records 16A and heuristic database 16B may be stored in the MSC 14 or in a combined MSC 14/VLR 16. It should also be understood that the heuristic database 16B stored, for example, in the VLR 16 may be modified by the system operator to better optimize paging performance within the system.

An example of a particular heuristic or algorithm stored within the heuristic database 16B used in accordance with the present invention is described hereinafter.

```
IF paging history =                                    (H1)
     TIME ≤ 1 minute;
     TOTAL ≥ 3;
     SUCC = False (unsuccessful previous page);
     TIME_RESP = 0 (not applicable)
     NUM_UNSUCC ≥ 3;
     ID = (cell identifier);
THEN
     FIRST PAGE:   GLOBAL,  PAGING  TIMEOUT  =  8
seconds;
     SECOND PAGE:   NO_SECOND_PAGE.
```

A mobile subscriber satisfying the above paging criteria, set forth in the above illustrative rule or heuristic, is most likely out of range since there have been three or more attempts to page them within the last time period without response. Accordingly, local paging is superfluous and not performed. Instead, the system immediately performs a global page. As discussed, this saves paging resources and also reduces the time before

indication is sent to the calling subscriber, which in turn saves network resources since the calling party completes their call sooner.

Another heuristic stored within the heuristic database 16B is described below:

```
IF paging history =                                    (H2)
     TIME ≤ 5 minutes;
     TOTAL = 1;
     SUCC = True (successful last page);
     TIME_RESP = 1 second;
     NUM_UNSUCC = 0;
     ID = (cell identifier).
THEN
     FIRST PAGE:   page cell ID and surrounding
cells;
     SECOND PAGE:  GLOBAL.
```

Here, the mobile subscriber has just answered a page within the last 5 minutes. Thus, the subscriber is likely to still be within the particular cell, e.g., cell 22e in FIGURE 3, or one of the immediately surrounding cells, e.g., cells 22a, 22b, 22c, 22d and 22f in LA 18f (and the cells adjoining cell 22e in the neighboring LA 18, not shown). Accordingly, paging resources may be optimized by first targeting the specific cells in question. If unsuccessful, the subscriber is then preferably paged globally.

In the aforedescribed manner, the twin goals of preservation of system resources and customer satisfaction may be achieved.

It should additionally be understood that the data records 16A may include a priority level for the page, e.g., the priority field illustrated in FIGURE 4. For example, a mobile subscriber (or a caller) may pay a higher price for an automatic global page, thereby superseding the aforedescribed protocols. Similarly, a subscriber may indicate a low priority, e.g., if the respective MS 20 is only used within a narrow area.

It should further be understood that the aforementioned parameters, i.e., TIME, TOTAL, SUCC, etc., are preferably initialized at the time of registration or IMSI attachment.

It should also be understood that the heuristic database 16B is preferably a dynamic database, which, in addition to be modified by the system operator, is able to modify itself as it accumulates a multiplicity of subscribers' data, and respond to patterns within that data to better serve the subscriber base. For example, in either or both of heuristics H1 and H2, described hereinbefore, the variable limits for TIME and TOTAL, for example, may be manually or automatically changed in response to subscribers' usage and system needs.

The previous description is of preferred embodiments for implementing the invention, and the scope of the invention should not necessarily be limited by this description. The scope of the present invention is instead defined by the following claims.

WHAT IS CLAIMED IS:

1. A telecommunication system having a multiplicity of separate communication areas (12) therein, a multiplicity of mobile stations (20) being operable within said areas, a location register for the system governing telecommunications with said multiplicity of mobile stations (20) within said multiplicity of areas (12), circuitry within said location register for controlling paging of said mobile stations (20) within said areas, said circuitry comprising:

a plurality of operational records (16A) within said location register, each of said plurality of operational records (16A) respectively corresponding to a given one of said mobile stations (20); and

a rules database (16B) within said location register, said rules database (16B) comprising a plurality of discrete rules, said system communicating with a given mobile station (20) via reference to said corresponding operational record (16A) for said given mobile station (20) and a respective rule within said rules database (16B).

2. The telecommunication system according to claim 1, wherein said location register is a visitor location register (16).

3. The telecommunication system according to claim 1, wherein each of said operational records (16A) contains therein an identification field, said identification field in a particular operational record corresponding to a particular mobile station (20).

4. The telecommunication system according to claim 3, wherein said identification field contains an IMSI number.

5. The telecommunication system according to claim 3, wherein each of said operational records (16A) contains therein a time field, said time field containing a value indicating the time since the last page attempt to said particular mobile station (20).

6. The telecommunication system according to claim 3, wherein each of said operational records (16A) contains a total attempts field, said total attempts field containing a value indicating the number of page attempts to said particular mobile station (20) within a given period.

7. The telecommunication system according to claim 3, wherein each of said operation records contains therein a success flag field, said success flag field containing a value indicating the result of a previous page attempt to said particular mobile station (20).

8. The telecommunication system according to claim 7, wherein said success flag field contains a Boolean value.

9. The telecommunication system according to claim 7, wherein said previous page attempt is the last page attempt to said particular mobile station (20).

10. The telecommunication system according to claim 3, wherein each of said operational records (16A) contains therein a response time field, said response time field containing a value indicating the time since the last successful page attempt to said particular mobile station (20).

11. The telecommunication system according to claim 3, wherein each of said operational records (16A) contains therein a total failed attempts field, said total failed

attempts field containing a value indicating the number of unsuccessful page attempts to said particular mobile station (20) within a given period.

12. The telecommunication system according to claim 3, wherein each of said operational records (16A) contains therein a location field, said location field containing a value indicating the last known location of said particular mobile station (20) within said telecommunication system.

13. The telecommunication system according to claim 12, wherein said value indicates a particular communications area.

14. The telecommunication system according to claim 13, wherein said value indicates a particular Location Area.

15. The telecommunication system according to claim 13, wherein said value indicates a particular cell.

16. The telecommunication system according to claim 3, wherein each of said operational records (16A) contains therein a priority field, said priority field indicating a priority level for a page to said particular mobile station (20).

17. A method for paging a mobile station (20) within a telecommunication system, said system being divided into a multiplicity of separate communication areas (18a-f), said mobile station (20) being one of a multiplicity of mobile stations (20) operable within said areas, said system including a location register therein for governing telecommunications with said multiplicity of mobile stations (20) within said multiplicity of areas (18a-f), said location register containing a plurality of

operational records (16A) each corresponding to a respective mobile station (20), and a rules database (16B), said method comprising the steps of:

determining a plurality of operational parameters associated with said mobile station (20), said operational parameters being stored within a multiplicity of discrete fields within a respective operational record (16A); and

applying at least one rule within said rules database (16B), said at least one rule governing paging communications to said mobile station under said operational parameters.

18. The method according to claim 17, wherein said step of applying at least one rule comprises:

reviewing a multiplicity of said rules within said rules database (16B);

determining a particular rule within said rules database (16B) applicable to said mobile station (20) under said operational parameters; and

applying said particular rule, whereby paging communication to said mobile station (20) under said operational parameters is optimized.

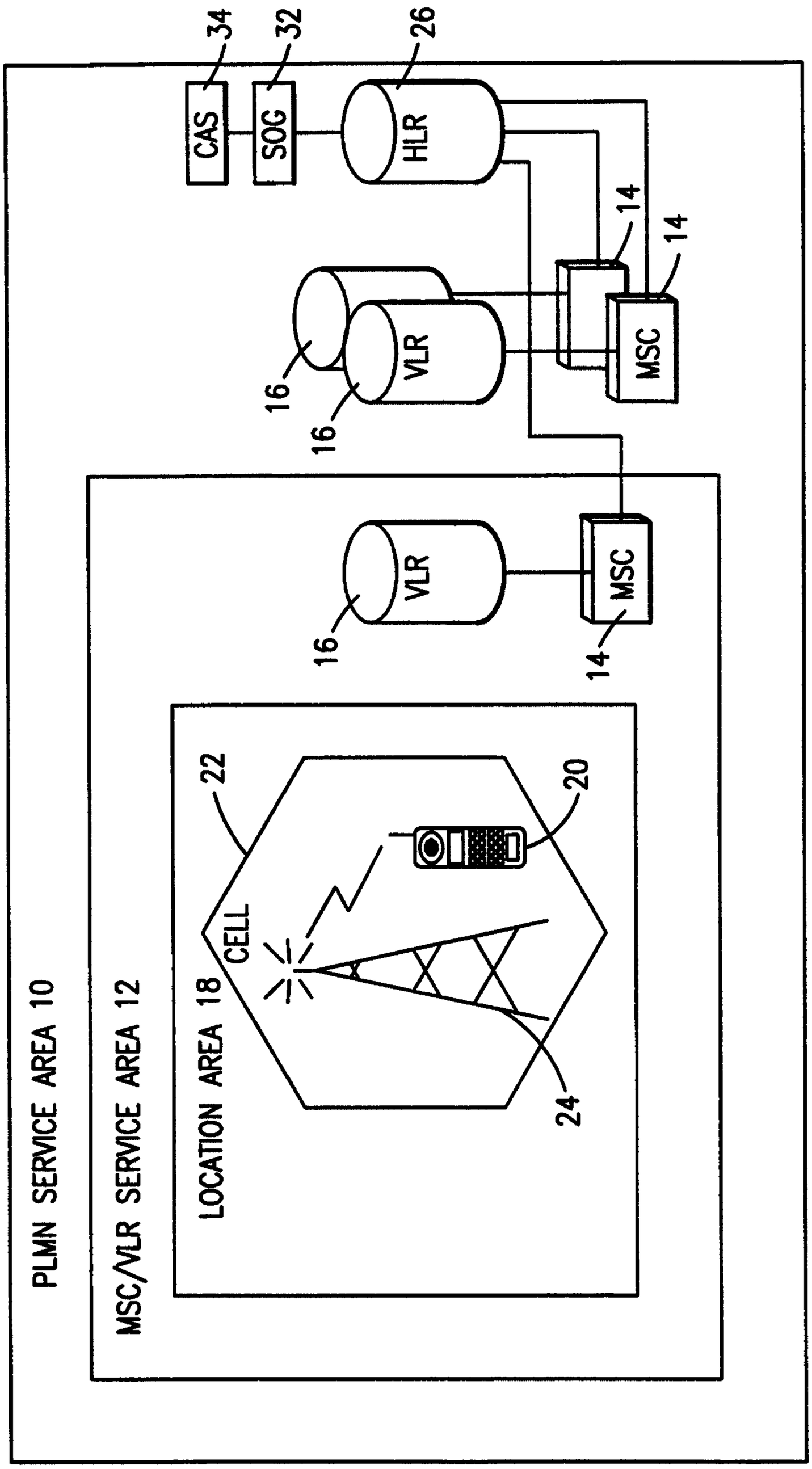

34
32
26
CAS
SOG
HLR
14
14
16
16
VLR
MSC
16
VLR
14
MSC
PLMN SERVICE AREA 10
MSC/VLR SERVICE AREA 12
LOCATION AREA 18
CELL
22
20
24

FIG. 1

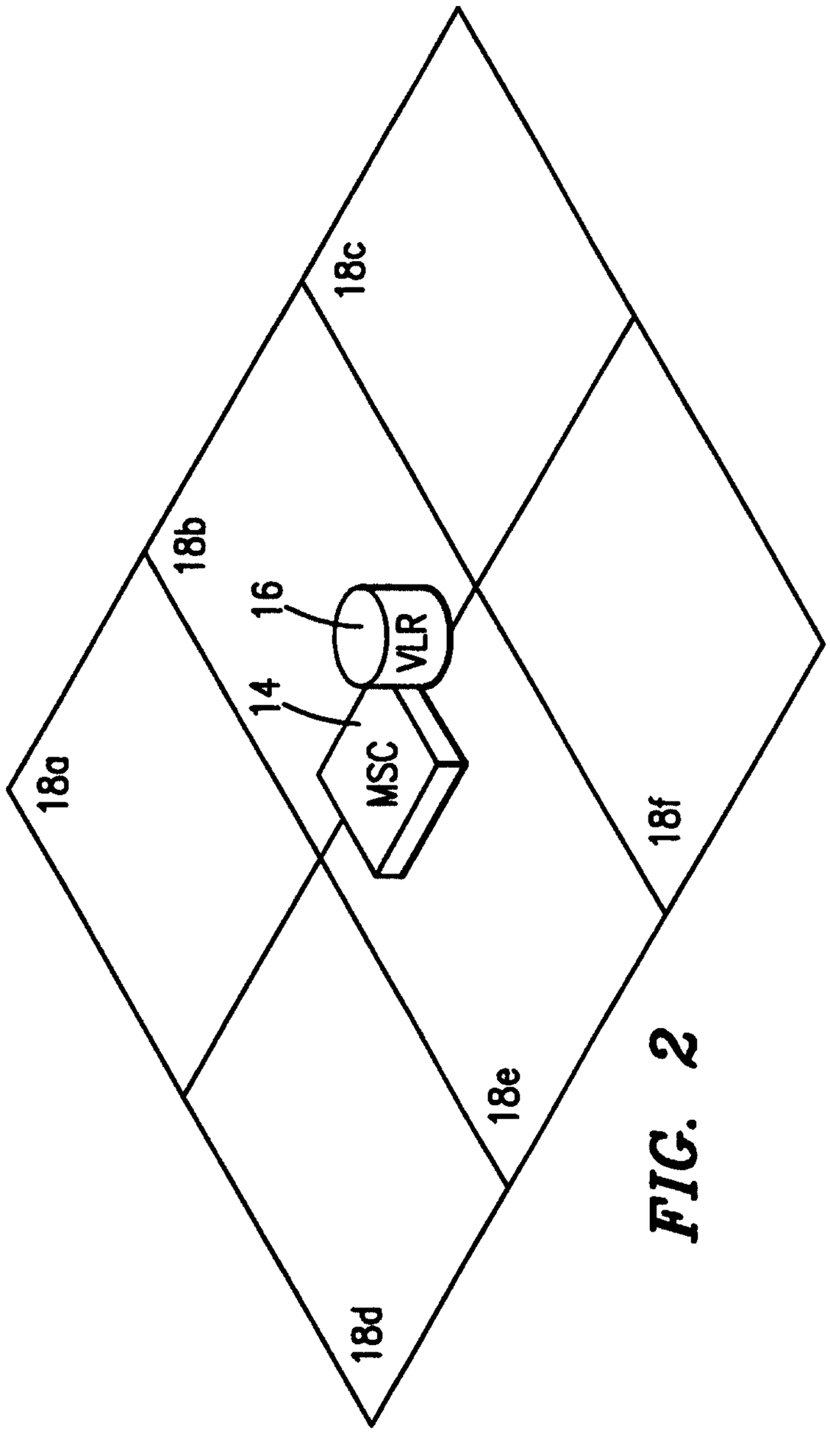


FIG. 2

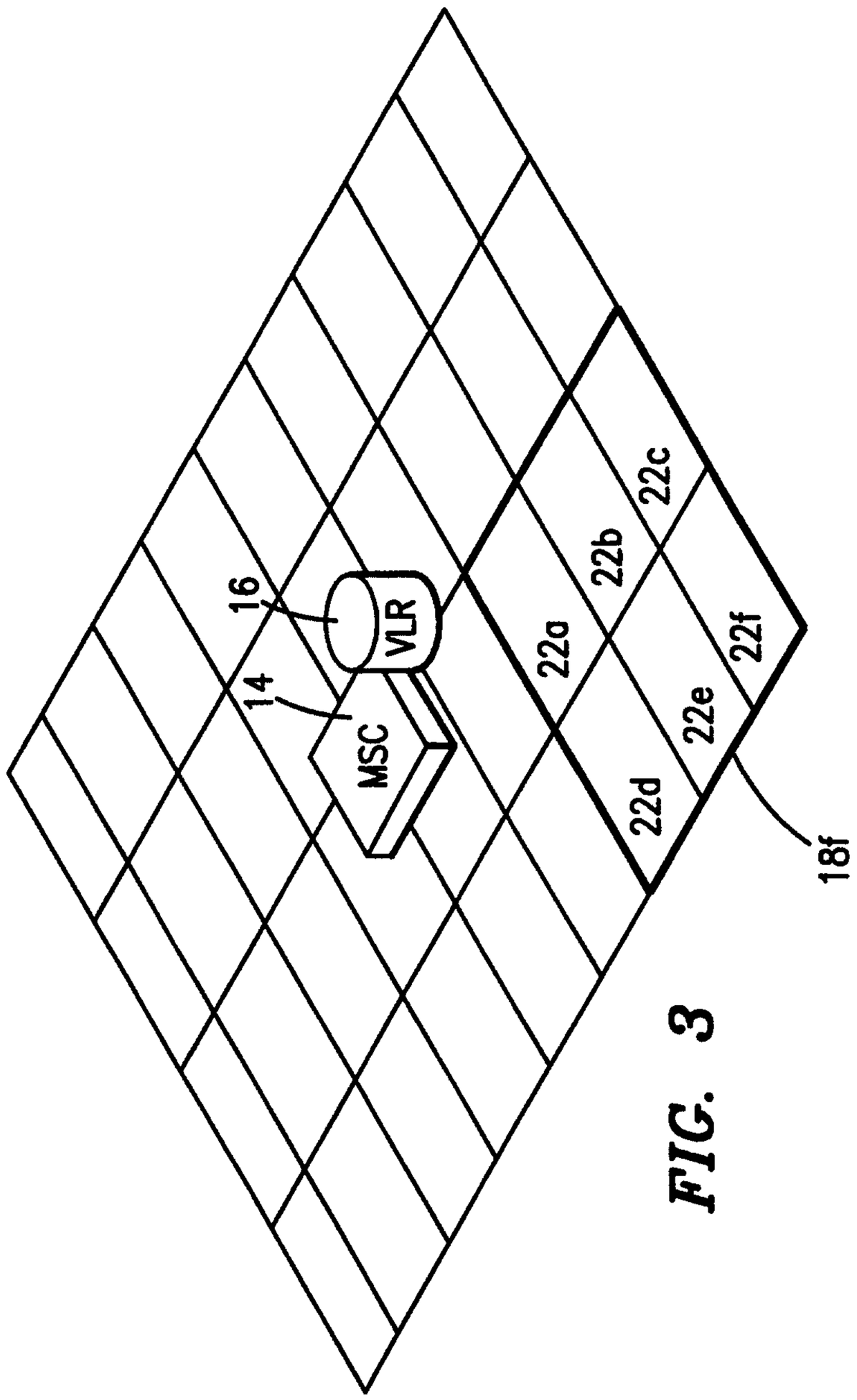


FIG. 3

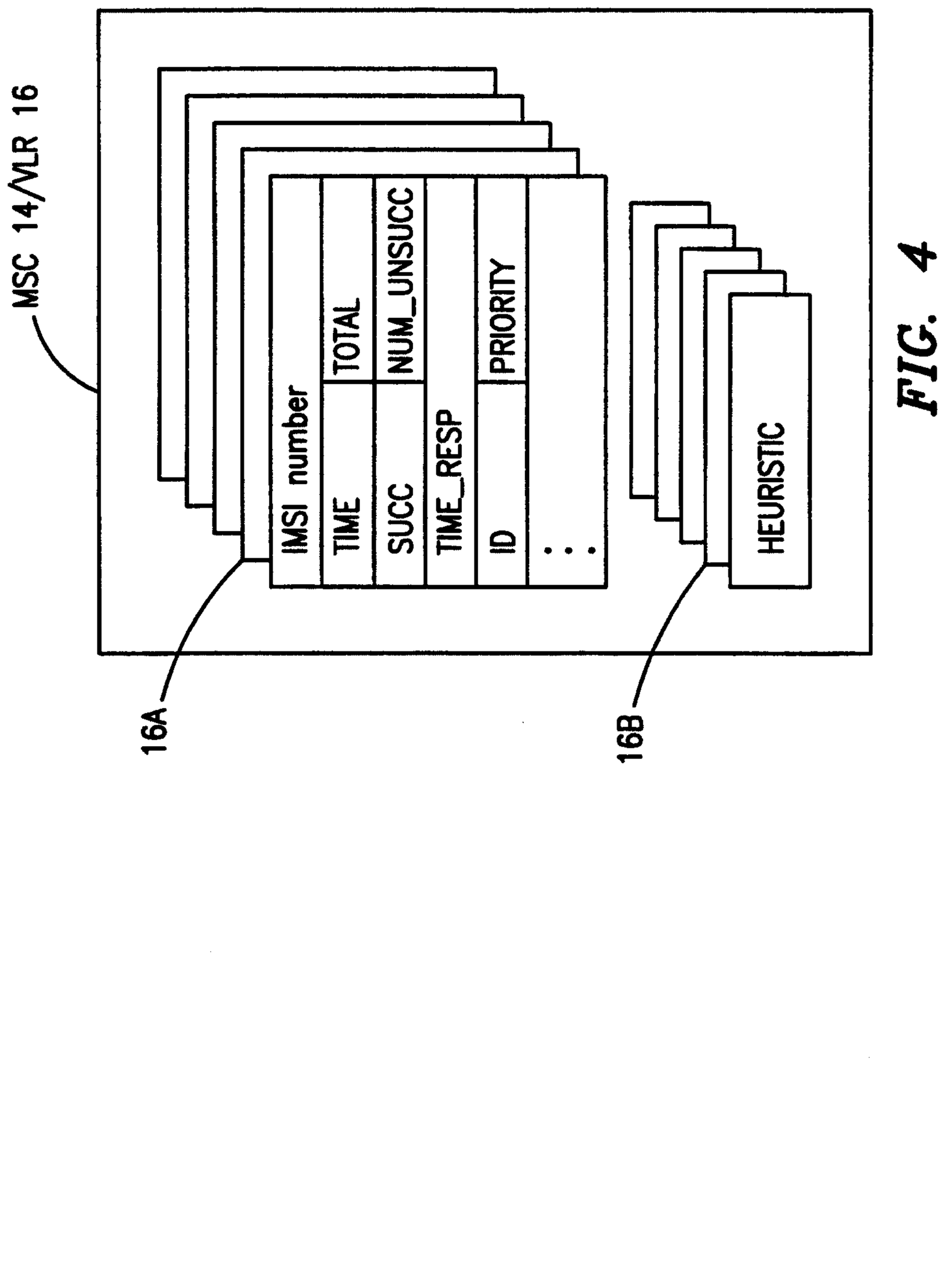

MSC 14/VLR 16
IMSI number
TIME
TOTAL
SUCC
NUM_UNSUCC
TIME_RESP
ID
PRIORITY
HEURISTIC
16A
16B

FIG. 4