DATABASE FAILURE RESTORATION SCHEME IN GSM NETWORK

A DISSERTATION

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CERTIFICATE

*This is certify that the Dissertation entitled "**Database Failure Restoration Scheme in GSM Network**" submitted by Kamal Narayan Rawat, Roll No. 10/CO/2000(1531) is being submitted to the University of Delhi towards the partial fulfillment for the degree of Master of Engineering in Computer Technology and Applications. To the best of my knowledge the work in this dissertation has not been submitted in part or full for any other degree or diploma in any other College or University.*

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Kamal Narayan Rawat

ABSTRACT

Global System for Mobile Communication (GSM) is a digital cellular Telephony system. That has gained the worldwide acceptance. It allows users universal and worldwide access to the information and ability to communicate with each other irrespective to their location and mobility.

A Personal Communication Services (PCS) network tracks the location of mobile stations (MSs) or mobile phones so that incoming call can be delivered to the subscribers. For the location tracking purpose a PCS service area is partitioned into several location areas (LAs). Each location area consist of a group of base stations that communicate with MSs using radio contact. The major task of the mobility management [1] is to update the location of an MS, when it moves from one location area to another. The procedure of location updating is called the registration [3], which is initiated by the MS.

The base station continuously broadcast the corresponding LA address to the MS. When an MS receive a different LA address it sends a registration[3] massage to the network. The location information are stored in the PCS mobility database called the home location register (HLR)[1] and visitor location register (VLR)[1]. For every local area, LA, there is a corresponding VLR. When an MS visits the LA, a temporary record of the MS is created in the VLR to indicate its location (ie, the LA address). For every MS, there is a permanent record stored in the HLR. The record stores the address of the VLR visited by the MS. In the architecture of GSM, the base stations of an LA are connected to a mobile switching center (MSC). Thus, an MSC covers several Las, as shown in Fig,1.One or more MSCs are connected to a VLR, and exchange location information with the VLR Similarly. The VLR communicate with the HLR to exchange location information.

Statement of the problem

If the location database fails [1] the location information will be lost which will degrade the services offered to the subscribers. Thus fault tolerance[1,2] of the location database becomes an important issue for the PCS network management here we are simulating the failure restoration [1] procedure in the GSM.

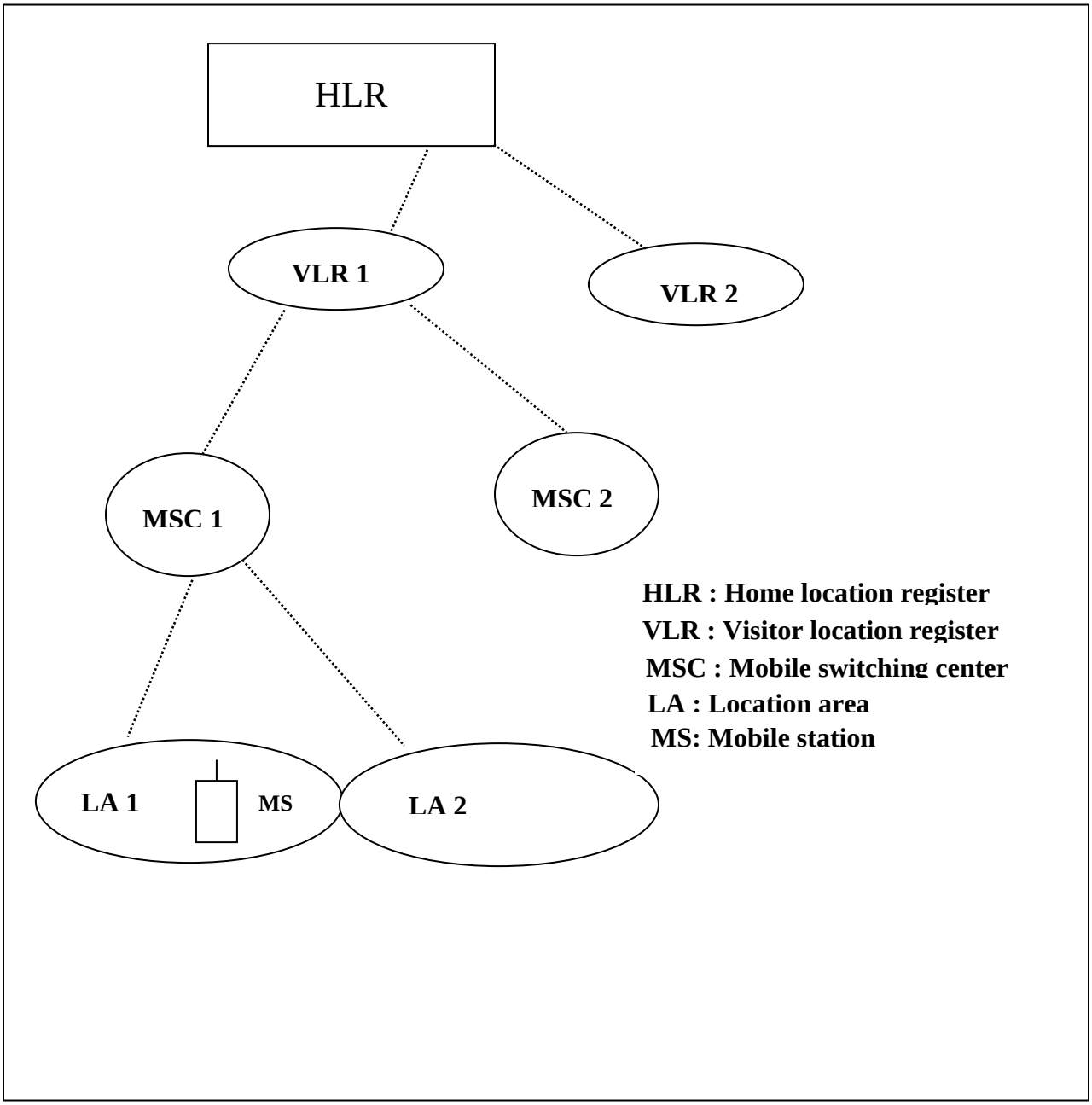

Figure 1. The PCS Mobility management architecture

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CHAPTER 1
REVIEW OF THE CELLULAR MOBILE SYSTEMS-DEVLOPMENT

During the early 1980s, analog cellular telephone systems[6] were experiencing rapid growth in Europe, particularly in Scandinavia and the United Kingdom, but also in France and Germany. Each country developed its own system, which was incompatible with everyone else's in equipment and operation. This was an undesirable situation, because not only was the mobile equipment limited to operation within national boundaries, which in a unified Europe were increasingly unimportant, but there was also a very limited market for each type of equipment, so economies of scale and the subsequent savings could not be realized.

The Europeans realized this early on, and in 1982 the Conference of European Posts and Telegraphs (CEPT) formed a study group called the Groupe Special Mobile (GSM) to study and develop a pan-European public land mobile system. The proposed system had to meet certain criteria:

1. Good subjective speech quality
2. Low terminal and service cost
3. Support for international roaming
4. Ability to support handheld terminals
5. Support for range of new services and facilities
6. Spectral efficiency
7. ISDN compatibility

In 1989, GSM responsibility was transferred to the European Telecommunication Standards Institute (ETSI), and phase I of the GSM specifications [6] were published in 1990. Commercial service was started in mid-1991, and by 1993 there were 36 GSM networks in 22 countries. Although standardized in Europe, GSM is not only a European standard. Over 200 GSM networks (including DCS 1800 and PCS1900) are operational in 110 countries around the world. In the beginning of 1994, there were 1.3

million subscribers worldwide , which had grown to more than 55 million by October 1997. With North America making a delayed entry into the GSM field with a derivative of GSM called PCS1900, GSM systems exist on every continent, and the acronym GSM now aptly stands for Global System for Mobile communications.

The developers of GSM chose an unproven (at the time) digital system, as opposed to the then-standard analog cellular systems like AMPS in the United States and TACS in the United Kingdom. They had faith that advancements in compression algorithms and digital signal processors would allow the fulfillment of the original criteria and the continual improvement of the system in terms of quality and cost. The over 8000 pages of GSM recommendations try to allow flexibility and competitive innovation among suppliers, but provide enough standardization to guarantee proper interworking between the components of the system. This is done by providing functional and interface descriptions for each of the functional entities defined in the system.

CHAPTER 2
AN OVERVIEW OF THE GSM

European public cellular system in 900 MHz. Range. The basic criteria for their proposed system were

1. Good subjective speech quality.
2. Low terminal and service cost.
3. Support to international roaming.
4. Ability to support hand held terminal
5. Spectral efficiency
6. ISDN compatibility
7. Use of SIM cards.

GSM had a huge success by 1989.

2.1 GSM Architecture

GSM consist of many subsystems such as Mobile Station (MS), Base Station Subsystem (BSS), Network and Switching Subsystem (NSS). GSM Architecture [19,22] shown Fig. 2

2.1.1 Base Station System:- The BSS connect to the MS through a radio interface and also connect to the NSS. The BSS consists of a base transceiver station (BTS) located are antenna site and a base station controller (BSC.) Transcoder /rate adaptation unit (TRAU) carry out encoding and speech decoding and rate adaptation for transmitting data. As a support of the BTS. The TRAU may sited away from the BTS. Usually at the MSC. In this case, the low transmission rate of speech code channels allows more compressed transmission between the BTS and the TRAU. Which is sited at the MSC.

2.1.1.1 MS (Mobile Station):- The MS includes the mobile equipment and the Subscriber identity module (SIM) is subscriber module, which store all the

subscribers relelated information. When the SIM is inserted into the mobile equipment the relevant information is checked and a call is then delivered to the mobile station. the mobile equipment is not associated with the caller's number contained in the SIM and hence subscriber can use any mobile equipment.

2.1.1.2 BSC (Base Station Controller):- The BSC controls and supervises a number of BTS and radio connections in the system.It handles the

1. administration of cell data.
2.the locating algorithm.
3.orders handovers.

2.1.1.3 BTS (Base Tranceiver Station) :- is the radio equipment required to serve one cell. It contain the antenna system, radio frequency power amplifiers, and digital signaling equipment.

2.1.2 Switching System :- The switching system(SS) the functional units deccribed in the following section.

2.1.2.1 MSC(Mobile Switching Center):- The MSC is responsible for setting up ,routing and supervising calls to and from the mobile station

2.1.2.2 Gateway MSC (GMSC) :- The GMSC [23] is an MSC serving as an interface between the mobile network and other network, such as Public switched Telephony Network(PSTN) and Integrated services Digital Networks(ISDN) for mobile terminating calls. The MSC which is directly connected to the PLMN/ISDN network is referred to as Gateway MSC (GMSC).

1. This is the only MSC in the network connected to the HLR .

2. If a network, delivering a call to the PLMN cannot interrogate the HLR the call is routed to an GMSC.

3.The GMSC will interrogate the appropriate HLR and the route the call to the MSC where mobile station is currently located.

4.the MSC which performs the routing function to the actual location of MS is called the GMSC.

2.1.2.3 Visitor Location Register(VLR):- The VLR temporarily store information about the MS currently visiting its service area. The VLR is the functional unit that dynamically stores subscriber information, such as location area, when the subscriber is located in the area controlled by this VLR.When roaming mobile enters and MSC area, this MSC Warm the associated VLR of this situation and VLR start location updation procedure.

2.1.2.4 Home Location Register (HLR):- The HLR database stores and manages all mobile subscriptions belonging to a specific operator. The HLR stores permanent data about subscribers ,including subscribers supplementary services, location information,and authentication parameters. When a person buys a subcription, it is registered in the operators HLR. Two kinds of information are stored in the HLR.

1. Subscriber information
1.1 Teleservices subscription information
1.2 Restrictions (barring related data)
1.3 Location information
1.4 Supplementary service related information
1.5 Roaming related information
1.6 Pre-paid subscription data

2. This information enables the changing & routing of calls towards the MSC where the MS is located

2.1 IMSI

2.2 MSIDN

2.3 VLR address

For prepaid subscriber following additional information is stored

1. Amount of coupon
2. Validity period after recharge
3. Balance amount of subscribers
4. Grase period after coupon expiry

2.12.5Authentication center (AUC):- The AUC [23,19] database connected to the HLR.The AUC provides the HLR with authentication parameters.

2.1.2.6 Equipment Identity Register(EIR):- The EIR [23] database validates mobile equipment. the MSC/VLR can request to EIR to check if MS has been stolen (black listed), Not type-approved(Gray listed), or normal registered (white listed), or Unkown.

CHAPTER 3

MOBILITY DATABASES

In order to contain the information about the current location of mobile phones there are two types of database in the GSM system-

1. HLR Database
2. VLR Database

3.1 HLR Database

The HLR is a database used for mobile user information management. All permanent subscriber data are stored in this database. An HLR record consist of three type of information-

1. Mobile station information includes the international Mobile Subscriber identity (IMSI) used by the mobile station to access the network, and the Mobile station ISDN Number (MSISDN), the ISDN number (i.e.”phone number”) used by caller to access the mobile station.
2. Location information includes the ISDN number (address) of a VLR, and the ISDN number (address) of an MSC. This information indicates the VLR and MSC where the MS resides. The HLR obtains this information from the VLR during the registration[3] operation.
3. services information includes service subscription, service restrictions, and supplementary service. This information is provided by the subscriber.

3.2 VLR Database

The VLR is a database of the service area visited by an MS. The VLR Contains all subscriber data of an MS required for call handing and other purposes. Similar to the HLR, the VLR information consist of three parts-

1. mobile station information includes IMSI, MSISDN, and temporary mobile subscriber identity (TMSI). In GSM.
2. location information includes the MS number and LA identity (LAI). This information indicates the MSC and LA where the MS resides.

3. service information includes a subset of the service information in the HLR. The VLR obtains this information from the HLR during the MS registration operation.

Note that in the mobility databases[4], the MS information and service information are seldom updated. On the other hand, the location information is modified every time the MS moves. Thus after a database failure[1], the approaches to recovering these two types of information are different. We also note that both the HLR and VLR maintain the MSC information. This redundant information will be used in VLR failure restoration.

CHAPTER 4
DATABASE FAILURE AND RESTORATION

The details of the location update and the call delivery procedures can be found in [12]. These procedures utilize the location information in the HLR/VLR, and if the mobility databases fail, the system will not be able to track the MS. To guarantee fault tolerance of GSM [1] mobility management, the failure restoration to the mobility databases is essential. This section describes the failure restoration procedures [13,14] for both the VLR and HLR. Specifically, VLR failure recovery largely consists of asking the HLR for the relevant information on a need-to-know basis. HLR failures are more serious, and recovery is primarily based on restoration from a backup.

4.1 VLR Failure Restoration

After a failure, the service information of a VLR record is recovered by the first contact between the VLR and HLR (of the corresponding MS). The location information is recovered by the first radio contact between the VLR and MS. The MS information is recovered by the contact with either the HLR or the MS. The VLR record restoration is initiated by one of the following three events.

MS Registration :- Since the VLR record is erased after the failure, the VLR assumes that the registration is for inter-VLR movement (note that the MS may move between two LAs within an MSC, which is referred to as *intra-MSC* move-ment). Following the normal registration procedure [5], the VLR record is recovered.

MS Call Origination :- When the VLR receives the call origi-nation request from the MSC [1], the VLR record for the MS is not found. The VLR considers the situation as a system error (the error cause is “Unidentified Subscriber”). The request is rejected, and the MS is asked to initiate the loca-tion registration procedure. After the registration, the VLR record is recovered.

MS Call Termination :- The call termination message flow is illustrated in Fig. 3

Step 1 :- When the MSISDN is dialed by a user of the public switched telephone network (PSTN), the call is routed from the originating switch in the PSTN to a gateway MSC (or an ISDN exchange) by an SS7 ISDN User Part (ISUP) [9] initial address message (IAM). The IAM message reserves the voice trunk between the originating switch and the gateway MSC.

Step 2 :- To obtain the routing information (i.e., the actual location of the MS), the gateway MSC interrogates the HLR by sending a routing query message. The message consists of the MSISDN of the MS (i.e., the phone number of the MS) and other related information.

Step 3 :- The HLR sends a query message to the VLR to obtain the mobile station routing number (MSRN) which indicates the MSC and LAI of the MS. The message consists of the IMSI, MSC number, and other related information. Note that the MSC number was maintained in both the HLR and VLR. The VLR searches the MS record by using the received IMSI. Since the record was erased after the VLR failure, the search fails. The VLR creates a VLR record for the MS (note that both the service and location information are not available in this newly created record). Then Steps 4 and 5 are executed in parallel.

Steps 4 and 7 :- Since the VLR does not have the routing information, it uses the MSC number provided by the HLR to create the MSRN. The number is sent back to the gateway MSC to set up the call in Step 8.

Steps 5 and 6 :- The VLR recovers the ser-vice information of the VLR record by exchanging a data restoration message pair with the HLR. At this point, the service infor-mation of the VLR record has been recovered. However, the

location information (specifically, the LAI number) is still not available. This information will be recovered at Step 11 below.

Step 8 :- After the gateway MSC has received the MSRN in Step 7, an IAM message is sent to the target MSC to reserve the voice trunk between the gateway and target MSCs.

Steps 9 and 10 :- The target MSC does not have the LA information of the MS. In order to proceed with the call setup procedure, the MSC sends a query in Step 9 to the VLR to find out the LA of the MS. Unfortunately, the VLR does not have the LAI information due to the database failure. The VLR asks the MSC to search the LA of the MS in Step 10.

Steps 11, 12, and 13 :- The MSC initiates paging of the MS in all LAs (Step 11). If the paging operation is successful, the current LA address of the MS is sent back from the MSC to the VLR in Step 12. At this point the location information of the VLR record is recovered. The VLR acknowledges this restoration operation in Step 13.

Note that the LA searching operation (i.e., Step 11) is an expensive operation (every base station connected to the MSC must be paged). To avoid this "wide-area paging," the GSM system may ask the MSs to periodically reregister to the VLR. With periodic location updating, there is a better chance that the location information is recovered by the periodic location confirmation before the first call termination after the failure. Thus, expensive MS search operation is avoided. The selection of the frequency for location reregistration was studied in [15].

4.2 HLR Failure Restoration

For HLR, it is mandatory to save the updates into nonvolatile storage. Changes of service information are saved into the backup immediately after any update.

The location information is periodically checkpointed [1] into the backup. Note that service information update is infrequent (most subscribers never change the service profile after subscription), and the immediate backup update cost is acceptable.

After an HLR failure, the data in the backup are reloaded into the HLR. Data that have been changed in the period between the last backup checkpointing and restart of the HLR (this period is referred to as the *uncovered perio*d) can not be recovered. Thus, the following HLR restoration procedure is executed.

HLR Restoration Procedure

Step 1 :- The HLR sends a database reset message to the VLRs where its MSs are located.

Step 2 :- The VLR derives all MSs of the HLR, and for each MS the VLR sends a registration message to the HLR. After the location update operation, the HLR record is recovered.

Note that the above HLR restoration procedure is not robust because during the uncovered period, an MS may move into a VLR unknown to the HLR at the last checkpointing time. If so, the HLR will not be able to locate the VLR of the MS at Step 1 of the HLR restoration procedure.

Another problem of the GSM HLR restoration procedure is that the location information of a VLR may not be changed during the uncovered period. However, the HLR still asks the VLR to resend the information, which results in unnecessary overhead. This situation may occur if all MSs entering a VLR during the uncovered period eventually leave the VLR before the HLR fails.

So in the standard GSM HLR restoration procedure if the HLR contact to every VLR it will be an expensive process. So, it is desirable to identify the exact VLR,

that should be contacted by the HLR after an HLR failure. Here we are describing an algorithm to identify the exact VLRs.

4.3 The VLR Identification Algorithm

We have proposed an algorithm [4] to identify a superset of the VLRs to be contacted by the HLR after a failure. In this article, we propose an improved algorithm called the VLR
Identification Algorithm (VIA), which can identify the exact VLRs to be contacted by the HLR except for one case: due to the transient behavior of message sending, at the time of
HLR failure, this set of VLRs may be a bit larger than the set of “true” VLRs to be contacted by the HLR. To simplify the description, we assume that every VLR covers exactly one MSC. Extension of our algorithm to accommodate multiple MSCs is trivial. The VIA consists of three procedures: Procedure 1 for checkpointing, Procedure 2 for registration, and Procedure 3 for restoration. Procedure 1 periodically saves the HLR records into the backup, and Procedure 3 restores the HLR records when an HLR failure occurs. Procedure 2 performs the standard GSM registration [1,3] operations and keeps track of the VLRs that have been modified since the last checkpointing. (In Procedure 3, HLR will contact these VLRs to obtain correct user location information after an HLR failure.) Procedure 2 is based on the principle of counting where the HLR counts the number of new MSs that have entered a VLR since the last checkpointing. If such MSs exist, the VLR is marked in a list in the backup. Thus, at an HLR failure, the VLRs to be contacted by the HLR is in this list (which can be obtained in the backup). To implement the VIA, extra data structures are required in the HLR, as shown in Fig. 4 This figure only shows the fields of the HLR record required to exercise the VIA. In the backup, the extra data structure is a set *VLR_Lis*t* of VLRs that have been modified during the uncovered period. After a HLR failure, the HLR only needs to send the reset messages to the VLRs in

*VLR_List**. In the HLR, every record includes two extra fields, as illustrated in Fig. 4.

• The *ts* field indicates the time of the latest location update. In some GSM implementations, this field already exists for other purposes.

• The *PVLR* field contains the address of the VLR where the MS resided at the last checkpointing time. Thus, for any MS *p* we have

*HL*R*[p].*VLR* = *HL*R[p], *PVLR*

Two extra data structures are introduced to the HLR:

• *TS* is the last checkpointing (backup) time.

• *VLR_Counter* is a set of *(VL*R,*Coun*t) pairs, where *Count* represents the "effective number" of MSs entering the VLR during the uncovered period. In Fig. 4, there are three effective MSs in VLR *V* 1 . Note that an MS is not *effective* to the VLR if it has entered the VLR area but eventually left the area during the uncovered period. Also note that the VLRs in *VLR_Counter* are the VLRs in *VLR_List**.

The VIA works as follows. The HLR records are periodically saved into the backup by using the following checkpointing procedure.

VIA Procedure 1
Checkpointing:

Step 1 :- for every location entry *p* in *HLR** **do**

*HL*R[p]*.*VLR* := *HL*R[p].*VL*R;

Step 2 :- *TS* := current time;

Step 3:- for every location entry *p* in HLR **do**

HLR[p].*ts* := *TS*; *HL*R[p].*PVLR* := *HL*R[p].*VL*R;

Step 4 :- *VLR_Counter* ←Ø, *VLR_List** ←Ø;

In the checkpointing procedure, every location entry is saved into the backup (Step 1). The clock *TS* is set to the time of checkpointing (Step 2). The timestamp filed *ts* of every location entry in HLR is set to *TS* to indicate that the last location of the MS was updated no later than the latest check-pointing time *TS* (see Step 3). The *PVLR* is set to the current VLR address of the MS. Finally, both *VLR_Counter* and *VLR_List** are set to empty to indicate that no VLR has a new roaming MS at *T*S(Step 4).

Suppose that MS *p* moves into a VLR area *Vnew* at time t. Following the standard GSM registration procedure, a regis-tration message is sent from *Vnew* to the HLR. The following procedure at the HLR is triggered to perform the registration operation.

VIA Procedure 2
Registration:

Step 1:- (Update HLR)

Step 1.1 — *Vold* ←*HL*R[p].*VL*R;

/* *Vold* is the last *VLR* visited by p*/

Step 1.2 — *HL*R[p].*VLR* ←*Vnew* ;

/* *Vnew* is the current *VLR* visited by p*/

Step 1.3 — *told* ←*HL*R[p].*t*s;

/* *told* is the time when *p* entered *Vold* */

Step 1.4 — *HL*R[p].*ts* ←t;

/* *t* is the time when *p* entered *Vnew* */

Step 1.5 — Send a deregistration message to cancel the VLR entry of *p* at *Vold* ;

Step 1.6 — Send an acknowledgment to *Vnew* ;

Step 2 :- (Update the Vnew Count field in *VLR_Counte*r)

if *HL*R[p].*VLR* ≠*HL*R[p].*PVLR* **then**

/* *Vnew* is not the VLR visited by *p* at the last checkpoint-ing; thus, *p* is a “new” visitor to the VLR after the last checkpointing */

Step 2.1 — **if** *VLR_Coun*t[*Vnew*] exists **then**

*VLR_Counte*r[*Vnew*].*Count* := *VLR_Counte*r[*Vnew*].*Count* + 1;

Step 2.2 — **else** create *VLR_Counte*r[*Vnew*] and

*VLR_Lis*t*[*Vnew*];

*VLR_Counte*r[*Vnew*] := 1;

/* Steps 2 increments the number of MSs that entered *Vnew* after the last checkpointing*/

Step 3 :- (Update the *Vold* counter entry)

if *told* > *TS* **and** *Vold* ≠*HL*R[p].*PVLR* **then**

/**p* enters *Vold* in the uncovered period and *Vold* is not the VLR visited by *p* at the last checkpointing */

Step 3.1 — *VLR_Counter[Vold].Count* := *VLR_Counte*r[*Vold*].*Count* – 1;

Step 3.2 — **if** *VLR_Counte*r[*Vold*].*Count* = 0 **then**

/* No effective MS is in *Vold* */

Step 3.2.1 — delete *VLR_Counte*r[*Vold*] and

*VLR_Lis*t*[*Vold*];

/* Step 3 decrements the number of MSs entered *Vold* after the last checkpointing */

In the registration procedure, the location information of the MS is updated (Step 1.2), its location record at the old VLR *Vold* is canceled (Step 1.5), and *Vnew* is acknowledged (Step 1.6). The last update time *told* is saved to be used in Step 3. At Steps 2 and 3 of Procedure 2, *VLR_Counte*r[] is used to count the “effective” number of MSs that entered the VLRs dur-ing the period *[T*S, t]. Note that if the

MS was in *Vnew* before *TS* (i.e., *HL*R[p].*VLR* = *HL*R*[p].*VLR* = *HL*R[p].*PVL*R), then the HLR may consider that the MS never moves out of the VLR, and there is no need to increment the VLR counter (and Step 2 is skipped). If the MS entered *Vold* in the uncovered period (i.e., *tsold* > *T*S) and *Vold* is not the VLR visited by the MS at the last checkpointing (i.e., *Vold* ≠ *HL*R[p].*PVL*R), then it implies that the movement into *Vold* is not effective because the MS has moved out of *Vold* at t. Thus, the *Vold* counter should be decremented by 1 as described in Step 3. If *Vold* is the VLR visited by the MS at the last checkpointing, the MS is never considered an effective MS (see Step 2). In this case, there is no need to decrement the *Vold* counter when the MS moves out of *Vold* .

If *VLR_Counte*r[V].*Count* > 1, any update to *VLR_Counte*r[V] will not invoke modification to *VLR_Lis*t*[]. In other words, access to the HLR backup is avoided. The purpose of Procedure 2 is to avoid updating the backup for every registration operation. After an HLR failure, Procedure 3 is executed to restore the HLR. In this procedure, the HLR restores the location entries from the backup and requests current status of the MSs from all VLRs that have updated the MS information between the last checkpointing time and the HLR failure time. Note that after the execution of VIA Procedure 2, *VLR_Lis*t* in the backup contains the VLRs the HLR should contact after an HLR failure. Due to the transient behavior of message sending, at the time of HLR failure, this set of VLRs may be a bit larger than the set of “true” VLRs to be contact-ed by the HLR.

VIA Procedure 3

Restoration :

Step 1 :- *TS* ← current time;

Step 2 :- **for** every location entry *p* in **do** /* The HLR recovers the MS records from the backup */

*HL*R[p].*PVLR* = *HL*R[p].*VLR* ← *HL*R[p]*.*VL*R; *HL*R[p].*ts* ← *T*S;

Step 3 :- **for** every VLR entry *V* in *VLR_Lis*t* **do**

/* The HLR initiates the standard GSM HLR failure restoration procedure */

Send a reset message to V;

CHAPTER 5
RESULTS & CONCLUSION

We have tested our program for HLR Database restoration which has performed the following operations successfully.

1.CHECKPOINTING:-The program store the HLR Database in the backup file periodically. HLR Database shown in the figure 5.

Table1								
SSSID	ms	imsi	subnam	profile	photo	roami	vlr	pvlr
1	11111	9425111111	Shashi Shekhar	Prepaid	Election Card	National	CHHATARPUR	TIKAMGARH
2	22222	9425122222	Kamal Narayan Rawat	Prepaid	Bank Pass Book	International	TIKAMGARH	CHHATARPUR
3	33333	9425133333	Vineet	Postpaid	Ration Card	International	DATIA	MUMBAI
4	44444	9425144444	Anjly	Prepaid	PAN Card	Regional	INDORE	INDORE
5	55555	9425155555	Raj	Postpaid	Driving Licence	International	GWALIOR	SAGAR

Figure.5 HLR Database

2.REGISTRATION & DEREGISTRATION:- The Program perform standard GSM registration operations and keep track of VLRs that have been modified since last checkpointing and update the Database of VLR & HLR accordingly shown in Fig. 7.

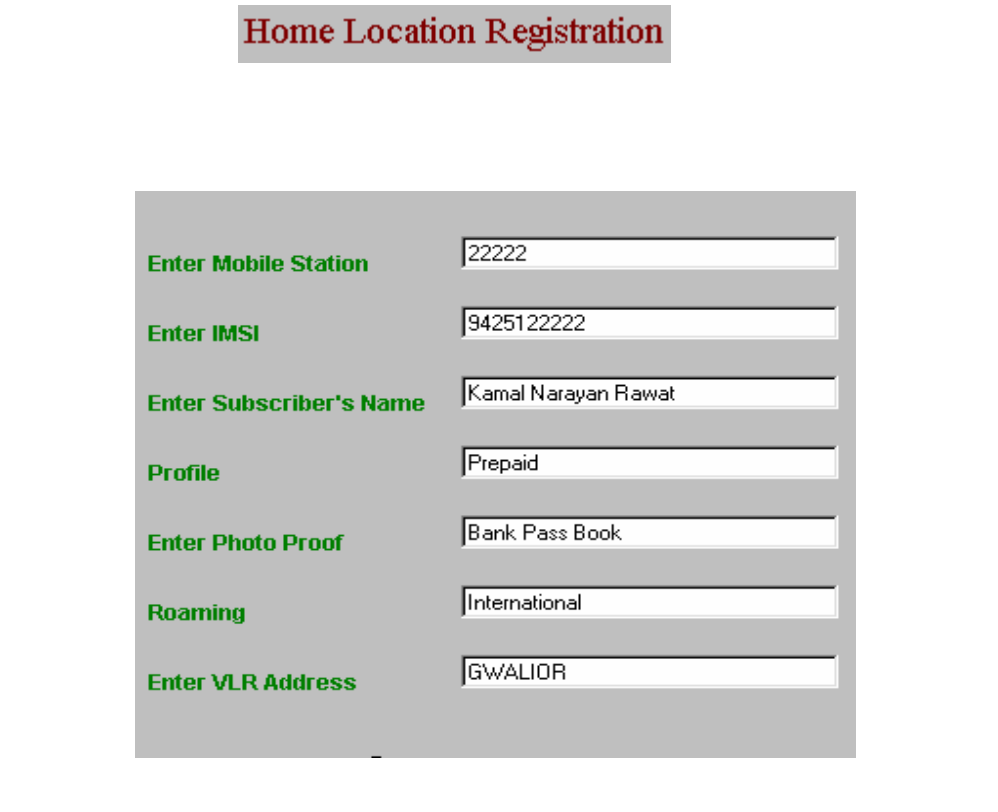

Figure 6 HLR Registration form

3.DATABASE RESTORATION:- In the case of HLR Database failure, the recover the Database from backup. In this program the HLR is contacting to only those VLRsin which there is some change in their Database during the uncovered period. List of MS change during uncovered period shown in figure 8.

Figure 8 List of MS change during uncovered period

This article presented failure restoration procedures in GSM shown in Fig. 9. In general, VLR failure recovery largely consists of asking the HLR for the relevant information on a need-to-know basis. HLR failures are more serious, and recovery is primarily based on restoration from a backup. The standard GSM HLR failure restoration procedure is not robust because the HLR may not contact the right VLRs to access the updated location information. To identify the VLRs to be contacted by the HLR after its failure, we propose an efficient VLR identifica-tion algorithm. The algorithm maintains timestamped HLR records and keeps counting the effective number of MSs entering each VLR since the last HLR checkpointing. As a result, at an HLR failure recovery the VLRs that need to be contacted for MS location update can easily be identified to speed the failure restoration procedure.

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Appendix : A
SOURCE CODE

```
Dim cn As ADODB.Connection
Dim rs As ADODB.Recordset
Dim con As ADODB.Connection
Dim ros As ADODB.Recordset
Dim con1 As ADODB.Connection
Dim ros1 As ADODB.Recordset
Dim con2 As ADODB.Connection
Dim ros2 As ADODB.Recordset
Dim con3 As ADODB.Connection
Dim ros3 As ADODB.Recordset
Dim con4 As ADODB.Connection
Dim ros4 As ADODB.Recordset
Dim con5 As ADODB.Connection
Dim ros5 As ADODB.Recordset
Dim var2 As String
Dim var22 As String
Dim var23 As String
Dim var24 As String
Dim var25 As String
'Dim var23, var24 As String     'wrong method
Dim ssscn As ADODB.Connection
Dim sssrs As ADODB.Recordset
Dim sssstr As String



Private Sub cmd_exit_Click()
Unload Me
End Sub

Private Sub cmd_first_Click()

rs.MoveFirst
DSPL

End Sub

Private Sub cmd_HLR_RECO_Click()
Form_HLR_RECO.Show
End Sub

Private Sub cmd_last_Click()
```

```
rs.MoveLast
DSPL

End Sub

Private Sub cmd_next_Click()

rs.MoveNext
If rs.EOF = True Then
rs.MoveLast
MsgBox "You are on last record.", vbOKOnly, "SSS"
End If

DSPL

End Sub

Private Sub cmd_previous_Click()

rs.MovePrevious
If rs.BOF = True Then
rs.MoveFirst
MsgBox "You are on first record.", vbOKOnly, "SSS"
End If

DSPL

End Sub

Private Sub cmd_refresh_Click()
DSPL
End Sub

Private Sub Command1_Click()

'Timer1.Interval = 1000      '1 SECOND = 1000 INTERVAL
'Dim sps As New FileSystemObject
'Label8.Caption = Label7.Caption + #12:01:00 AM#

cn.Close
Dim SourceFile, DestinationFile
SourceFile = "C:\SSS BSNL\SSS DB\HLR.mdb"   ' Define source file name.
DestinationFile = "C:\SSS BSNL\SSS DBBACKUP\HLR.mdb"   ' Define target file
name.
FileCopy SourceFile, DestinationFile   ' Copy source to target.
MsgBox "Current HLR has been successfully backed up", vbInformation, "SSS"
```

```
cn.Open

End Sub

Private Sub cmd_add_Click()

Text1.Text = Empty
Text2.Text = Empty
Text3.Text = Empty
Text4.Text = Empty
Text5.Text = Empty
Text6.Text = Empty
Text7.Text = Empty


End Sub

Private Sub cmd_save_Click()

If Text1.Text = "" Or Text2.Text = "" Or Text3.Text = "" Or Text4.Text = "" Or
Text5.Text = "" Then
MsgBox "Please fill up all the fields. One or more field is empty.", vbOKOnly,
"SSS"
Exit Sub
End If

rs.AddNew
rs!imsi = Text1.Text
rs!subnam = Text2.Text
rs!vlr = Text3.Text
rs!ms = Text4.Text
rs!profile = Text5.Text
rs!photo = Text6.Text
rs!roami = Text7.Text
rs.Update
VLR_CON
MsgBox "The record has been saved successfully.", vbInformation, "SSS"

End Sub

Private Sub Command2_Click()
Form_VLR_RECO.Show
End Sub
```

```
Private Sub Command3_Click()
NEW_ENTRY
End Sub

Private Sub Form_Activate()

Set cn = New ADODB.Connection
cn.Provider = "Microsoft.Jet.OLEDB.4.0"

'sssssssssss from load event sssssssssssssssssssss

Dim sss_path As String
sss_path = "C:\SSS BSNL\SSS DB\HLR.mdb"
'C'If Dir(db_path) = "" Then Exit Sub
If Dir(sss_path) = "" Then
MsgBox "The database 'HLR' either does not exist or is crashed. Please restore
the backed up recently", vbOKOnly, "SSS"
Dim SSourFile, SDestFile
SSourFile = "C:\SSS BSNL\SSS DBBACKUP\HLR.mdb"   ' Define source file
name.
SDestFile = "C:\SSS BSNL\SSS DB\HLR.mdb"   ' Define target file name.
FileCopy SSourFile, SDestFile   ' Copy source to target.
MsgBox "Recent HLR has been successfully restored", vbInformation, "SSS"
End If

cn.Open "C:\SSS BSNL\SSS DB\HLR.mdb"
Set rs = New ADODB.Recordset
rs.Open "Table1", cn, adOpenDynamic, adLockOptimistic, adCmdTable

'sssssssssssssssssssssssssssssssssssssssssssssssss

DSPL



Timer_HLRBACKUP.Interval = 50000
Timer1.Interval = 1000
Timer2.Interval = 30000
Timer3.Interval = 31000
Timer4.Interval = 32000
Timer5.Interval = 33000
Timer6.Interval = 34000

AUTOSAV
```

```
End Sub

Private Sub Label2_Change()

'Print "SSS"

End Sub

Private Sub Picture1_Click()

End Sub

Private Sub Label7_Change()
Adodc4.Refresh
DataGrid1.Refresh

End Sub

Private Sub Timer_HLRBACKUP_Timer()

cn.Close

sssstr = "select * from Table1"
SSSCNN
Do
sssrs!vlr = sssrs!pvlr
sssrs.Update
sssrs.MoveNext
Loop Until sssrs.EOF = True

ssscn.Close

Dim SourceFile, DestinationFile
SourceFile = "C:\SSS BSNL\SSS DB\HLR.mdb"   ' Define source file name.
DestinationFile = "C:\SSS BSNL\SSS DBBACKUP\HLR.mdb"   ' Define target file
name.
FileCopy SourceFile, DestinationFile   ' Copy source to target.
'MsgBox "Current HLR has been successfully backed up", vbInformation, "SSS"
Label8.Caption = "Current HLR has been successfully backed up at " +
Label7.Caption
cn.Open

'sssssssssssss right upto here sssssssssssssss

Dim cc(4) As String
Dim cntr As Integer
```

```
cntr = 0


'sssssssssssssssssss VLR

sssstr = "Select * from Table1"

SSSCNN_BACKHLR
List2.Clear
Do
cc(cntr) = sssrs!vlr
List2.AddItem cc(cntr)
sssrs.MoveNext
cntr = cntr + 1
Loop Until sssrs.EOF = True
ssscn.Close


End Sub

Private Sub Timer1_Timer()

Label7.Caption = Time
'If Label7.Caption = #1:47:00 AM# Then

End Sub

Private Sub VLR_CON()

Set con = New ADODB.Connection
con.Provider = "Microsoft.Jet.OLEDB.4.0"
con.Open "C:\SSS BSNL\SSS DB\VLR.mdb"
Set ros = New ADODB.Recordset
ros.Open "Table1", con, adOpenDynamic, adLockOptimistic, adCmdTable

ros.AddNew
ros!pvlr = Text3.Text
ros!ms = Text4.Text
ros.Update

End Sub

Private Sub Timer2_Timer()

var1 = Adodc1.Recordset!cod
Adodc2.RecordSource = "select * from table2 where SSSID = " & var1 & ""
```

```
Adodc2.Refresh
var3 = Adodc2.Recordset!loc_area
'ros1.AddNew
ros1!pvlr = var3
ros1!tim = Time
'ros1!ms = var2
ros1.Update

'sssssssssssssss updating pvlr of HLR sssss effectiving backup
sssstr = "Select * from Table1 where ms = " & var2 & ""

SSSCNN
sssrs!pvlr = var3
sssrs.Update
ssscn.Close

'sssssssssssssssssssssssssssssssssssssssssssssss


'Print "Mobile No " + var2 + " has moved to " + var3

If Adodc1.Recordset.EOF = True Then Exit Sub
Adodc1.Recordset.MoveNext

'SSSSSSSSSSS FOR SECOND SUBSCRIBER
SSSSSSSSSSSSSSSSSSSSSSS

'Dim db_path As String
'db_path = "c:\temp\repostry.mdb"
'If Dir(db_path) <> "" Then
    'Kill db_path
'End If

End Sub

Private Sub AUTOSAV()

Set con1 = New ADODB.Connection
con1.Provider = "Microsoft.Jet.OLEDB.4.0"

Dim db_path As String
db_path = "C:\SSS BSNL\SSS DB\VLR.mdb"
'C'If Dir(db_path) = "" Then Exit Sub
If Dir(db_path) = "" Then
MsgBox "The database 'VLR' either does not exist or is crashed. Please restore
the backed up recently", vbOKOnly, "SSS"
```

```
Dim SourFile, DestFile
SourFile = "C:\SSS BSNL\SSS DBBACKUP\VLR.mdb"   ' Define source file
name.
DestFile = "C:\SSS BSNL\SSS DB\VLR.mdb"   ' Define target file name.
FileCopy SourFile, DestFile   ' Copy source to target.
MsgBox "Recent VLR has been successfully restored", vbInformation, "SSS"
End If


con1.Open "C:\SSS BSNL\SSS DB\VLR.mdb"
Set ros1 = New ADODB.Recordset
ros1.Open "Table1", con1, adOpenDynamic, adLockOptimistic, adCmdTable
'var1 = ros!pvlr
var2 = ros1!ms
'Print var2
Adodc1.RecordSource = "select * from table3"
Adodc1.Refresh
Timer2_Timer

'sssssssssssssssssssssssssssssssssssssssssssss

sstr2 = "select * from table1 where SSSID = " & 2 & ""
Set con2 = New ADODB.Connection
con2.Provider = "Microsoft.Jet.OLEDB.4.0"
con2.Open "C:\SSS BSNL\SSS DB\VLR.mdb"
Set ros2 = New ADODB.Recordset
ros2.Open sstr2, con2, adOpenDynamic, adLockOptimistic, adCmdText

var22 = ros2!ms
'Print var2
Adodc1.RecordSource = "select * from table3"
Adodc1.Refresh
Timer3_Timer

'sssssssssssssssssssssssssssssssssssssssssssss

sstr3 = "select * from table1 where SSSID = " & 3 & ""
Set con3 = New ADODB.Connection
con3.Provider = "Microsoft.Jet.OLEDB.4.0"
con3.Open "C:\SSS BSNL\SSS DB\VLR.mdb"
Set ros3 = New ADODB.Recordset
ros3.Open sstr3, con3, adOpenDynamic, adLockOptimistic, adCmdText

var23 = ros3!ms
'Print var23
Adodc1.RecordSource = "select * from table3"
```

```
Adodc1.Refresh
Timer4_Timer

'sssssssssssssssssssssssssssssssssssssssssssssss

sstr4 = "select * from table1 where SSSID = " & 4 & ""
Set con4 = New ADODB.Connection
con4.Provider = "Microsoft.Jet.OLEDB.4.0"
con4.Open "C:\SSS BSNL\SSS DB\VLR.mdb"
Set ros4 = New ADODB.Recordset
ros4.Open sstr4, con4, adOpenDynamic, adLockOptimistic, adCmdText

var24 = ros4!ms
'Print var24
Adodc1.RecordSource = "select * from table3"
Adodc1.Refresh
Timer5_Timer

'sssssssssssssssssssssssssssssssssssssssssssssss

sstr5 = "select * from table1 where SSSID = " & 5 & ""
Set con5 = New ADODB.Connection
con5.Provider = "Microsoft.Jet.OLEDB.4.0"
con5.Open "C:\SSS BSNL\SSS DB\VLR.mdb"
Set ros5 = New ADODB.Recordset
ros5.Open sstr5, con5, adOpenDynamic, adLockOptimistic, adCmdText

var25 = ros5!ms
'Print var24
Adodc1.RecordSource = "select * from table3"
Adodc1.Refresh
Timer6_Timer

End Sub

Private Sub Timer3_Timer()

var11 = Adodc1.Recordset!cod2
Adodc2.RecordSource = "select * from table2 where SSSID = " & var11 & ""
Adodc2.Refresh
var33 = Adodc2.Recordset!loc_area
'ros2.AddNew
   'rs!imsi = Text1.Text
   'rs!subnam = Text2.Text
ros2!pvlr = var33
   'Print var2
```

```
ros2!tim = Time
'ros2!ms = var22
    'rs!profile = Text5.Text
ros2.Update

'sssssssssssssss updating pvlr of HLR sssss effectiving backup
sssstr = "Select * from Table1 where ms = " & var22 & ""

SSSCNN
sssrs!pvlr = var33
sssrs.Update
ssscn.Close

'sssssssssssssssssssssssssssssssssssssssssssssssssssssssss

'Print "Mobile No " + var22 + " has moved to " + var33
If Adodc1.Recordset.EOF = True Then Exit Sub
Adodc1.Recordset.MoveNext

End Sub

Private Sub DSPL()

On Error Resume Next
Text1.Text = rs!imsi
Text2.Text = rs!subnam
Text3.Text = rs!vlr
Text4.Text = rs!ms
Text5.Text = rs!profile
Text6.Text = rs!photo
Text7.Text = rs!roami

End Sub

Public Sub SSSCNN()

Set ssscn = New ADODB.Connection
ssscn.Provider = "Microsoft.jet.oledb.4.0"
ssscn.Open "C:\SSS BSNL\SSS DB\HLR.mdb"
Set sssrs = New ADODB.Recordset
sssrs.Open sssstr, ssscn, adOpenStatic, adLockOptimistic, adCmdText

End Sub

Private Sub Timer4_Timer()
```

```
var13 = Adodc1.Recordset!cod3
Adodc2.RecordSource = "select * from table2 where SSSID = " & var13 & ""
Adodc2.Refresh
var14 = Adodc2.Recordset!loc_area

ros3!pvlr = var14
ros3!tim = Time
ros3.Update

'sssssssssssssss updating pvlr of HLR sssss effectiing backup

sssstr = "Select * from Table1 where ms = " & var23 & ""

SSSCNN
sssrs!pvlr = var14
sssrs.Update
ssscn.Close

'sssssssssssssssssssssssssssssssssssssssssssssssssssssssss

'Print "Mobile No " + var23 + " has moved to " + var14
If Adodc1.Recordset.EOF = True Then Exit Sub
Adodc1.Recordset.MoveNext

End Sub

Private Sub Timer5_Timer()

var15 = Adodc1.Recordset!cod4
Adodc2.RecordSource = "select * from table2 where SSSID = " & var15 & ""
Adodc2.Refresh
var16 = Adodc2.Recordset!loc_area

ros4!pvlr = var16
ros4!tim = Time
ros4.Update

'sssssssssssssss updating pvlr of HLR sssss effectiing backup

sssstr = "Select * from Table1 where ms = " & var24 & ""

SSSCNN
sssrs!pvlr = var16
sssrs.Update
ssscn.Close
```

```
'sssssssssssssssssssssssssssssssssssssssssssssssssssssssss

'Print "Mobile No " + var24 + " has moved to " + var16
If Adodc1.Recordset.EOF = True Then Exit Sub
Adodc1.Recordset.MoveNext

End Sub

Private Sub NEW_ENTRY()

Dim aa(4) As String
Dim cnt As Integer
cnt = 0
Dim bb(4) As String
Dim cntt As Integer
cntt = 0
Dim jj(4) As String
Dim cnr As Integer
cnr = 0

List1.Clear
List3.Clear

'sssssssssssssssssss VLR

sssstr = "Select * from Table1"

SSSCNN_VLR
Do
aa(cnt) = sssrs!pvlr
jj(cnr) = sssrs!ms
'Print Spc(10); aa(cnt)
sssrs.MoveNext
cnt = cnt + 1
cnr = cnr + 1
Loop Until sssrs.EOF = True
ssscn.Close

'sssssssssssssssssssssssssss HLR

sssstr = "Select * from Table1"

SSSCNN
Do
bb(cntt) = sssrs!vlr
'Print Spc(10); bb(cntt)
```

```
sssrs.MoveNext
cntt = cntt + 1
Loop Until sssrs.EOF = True
ssscn.Close

'sssssssssssssssssssssssssss VLR SAVE

'sssstr = "Select * from Table4"

SSSCNN_VLR

If aa(0) <> bb(0) Then
'sssrs!dynvlr = aa(0)
List1.AddItem aa(0)
List3.AddItem jj(0)
End If
If aa(1) <> bb(1) Then
'sssrs!dynvlr = aa(1)
List1.AddItem aa(1)
List3.AddItem jj(1)

End If
If aa(2) <> bb(2) Then
'sssrs!dynvlr = aa(2)
List1.AddItem aa(2)
List3.AddItem jj(2)
End If
If aa(3) <> bb(3) Then
'sssrs!dynvlr = aa(3)
List1.AddItem aa(3)
List3.AddItem jj(3)
End If
If aa(4) <> bb(4) Then
'sssrs!dynvlr = aa(4)
List1.AddItem aa(4)
List3.AddItem jj(4)
End If

ssscn.Close

'ssssssssssssssssssssssssss



End Sub
```

```
Public Sub SSSCNN_VLR()
Set ssscn = New ADODB.Connection
ssscn.Provider = "Microsoft.jet.oledb.4.0"
ssscn.Open "C:\SSS BSNL\SSS DB\VLR.mdb"
Set sssrs = New ADODB.Recordset
sssrs.Open sssstr, ssscn, adOpenStatic, adLockOptimistic, adCmdText

End Sub

Private Sub Timer6_Timer()

var45 = Adodc1.Recordset!cod5
Adodc2.RecordSource = "select * from table2 where SSSID = " & var45 & ""
Adodc2.Refresh
var46 = Adodc2.Recordset!loc_area

ros5!pvlr = var46
ros5!tim = Time
ros5.Update

'sssssssssssssss updating pvlr of HLR sssss effectiing backup

sssstr = "Select * from Table1 where ms = " & var25 & ""

SSSCNN
sssrs!pvlr = var46
sssrs.Update
ssscn.Close

'sssssssssssssssssssssssssssssssssssssssssssssssssssssss

'Print "Mobile No " + var25 + " has moved to " + var46
If Adodc1.Recordset.EOF = True Then Exit Sub
Adodc1.Recordset.MoveNext


End Sub
Private Sub SSSCNN_BACKHLR()
Set ssscn = New ADODB.Connection
ssscn.Provider = "Microsoft.jet.oledb.4.0"
ssscn.Open "C:\SSS BSNL\SSS DBBACKUP\HLR.mdb"
Set sssrs = New ADODB.Recordset
sssrs.Open sssstr, ssscn, adOpenStatic, adLockOptimistic, adCmdText


End Sub
```

Appendix : B

List of Abbreviations and Acronyms

1G:-The first generation of analogue mobile phone technologies including AMPS, TACS and NMT

2G:-The second generation of digital mobile phone technologies including GSM, CDMA IS-95 and D-AMPS IS-136

2.5G:-The enhancement of GSM which includes technologies such as GPRS

3G:-The third generation of mobile phone technologies covered by the ITU IMT-2000 family

3GPP:-The 3rd Generation Partnership Project, a grouping of international standards bodies, operators and vendors with the responsibility of standardising the WCDMA based members of the IMT-2000 family

3GPP2:-The counterpart of 3GPP with responsibility for standardising the CDMA2000-based members of the IMT-2000 family. 3GPP2 is spearheaded by ANSI

8PSK:-Octantal Phase Shift Keying

A5/1/2/3/8X:-Encryption algorithms for GSM networks

AAL:-ATM Adaptation Layer

ABR:-Available Bit Rate

A-bis:-Interface between the BSC and BTS in a GSM network

ACTE:-Approvals Committee for Terminal Equipment

ACTS:-Advanced Communications Technologies and Services – a European technology initiative

ACU:-Antenna Combining Unit

ADPCM:-Adaptive Differential Pulse Code Modulation; a form of voice compression that typically uses 32kbit/s

AFC:-Automatic Frequency Control

AGCH:-Access Grant Channel; downlink only, BTS allocates a TCH or SDCCH to the MS, allowing it access to the network

Air interface:-In a mobile phone network, the radio transmission path between the base station and the mobile terminal

A-interface:-Interface between the MSC and BSS in a GSM network

AM:-Amplitude Modulation

AMPS:-Advanced Mobile Phone System, the analogue mobile phone technology used in North and South America and in around 35 other countries. Operates in the 800MHz band using FDMA technology

AMR:-Adaptive Multi-Rate codec. Developed in 1999 for use in GSM networks, the AMR has been adopted by 3GPP for 3G

Analogue:-The representation of information by a continuously variable physical quantity such as voltage

ANSI:-American National Standards Institute. An non-profit making US organisation which does not carry out standardisation work but reviews the work of standards bodies and assigns them category codes and numbers

API:-Application Program Interface

AoC:-Advice of Charge

ARIB:-Association of Radio Industries and Businesses. An organisation established by Japan's Ministry of Posts and Communications to act as the standardisation authority for radio communication and broadcasting

ARPU:-Average Revenue Per User

ASCII:-American Standard Code for Information Interchange

ASIC:-Application Specific Integrated Circuit

ASP:-Application Service Provider

Asymmetric Transmission:-Data transmissions where the traffic from the network to the subscriber is at a higher rate than the traffic from the subscriber to the network

A-TDMA:-Advanced Time Division Multiple Access

ATM:-Asynchronous Transfer Mode; a multiplexed information transfer and switching method in which the data is organised into fixed length 53-octet cells and transmitted according to each application's instantaneous need

AUC:-Authentication Centre; the element within a GSM network which generates the parameters for subscriber authentication

Bandwidth:- A term meaning both the width of a transmission channel in terms of Hertz and the maximum transmission speed in bits per second that it will support

BCH:-Broadcast Channels; carry only downlink information and are mainly responsible for synchronisation and frequency correction (BCCH, FCCH and SCH)

BCCH:-Broadcast Control Channel; the logical channel used in cellular networks to broadcast signalling and control information to all mobile phones within the network

B-CDMA:-Broadband Code Division Multiple Access

B-ISDN:-Broadband ISDN

BER:-Bit Error Rate; the percentage of received bits in error compared to the total number of bits received

BERT:-Bit Error Rate Test

Bit:-A bit is the smallest unit of information technology. As bits are made up using the binary number system, all multiples of bits must be powers of two i.e. a kilobit is actually 1024 bits and a megabit 1048576 bits. Transmission speeds are given in bits per second (bit/s)

Bluetooth:-A low power, short range wireless technology designed to provide a replacement for the serial cable. Operating in the 2.4GHz ISM band, Bluetooth can connect a wide range of personal, professional and domestic devices such a laptop computers and mobile phones together wirelessly.

BHCA :- Busy Hour Call Attempts; the number of call attempts made during a network's busiest hour of the day

BSC:-Base Station Controller; the network entity controlling a number of Base Transceiver Stations

BSS:-Base Station System/Subsystem

BTS:-Base Transceiver Station; the network entity which communicates with the mobile station

CAI:-Common Air Interface; a standard developed for the UK's public CT2 networks which enabled the same handset to be used on different networks

CAMEL:-Customised Application for Mobile network Enhanced Logic; an IN feature in GSM networks that enables users to carry personal services with them when roaming into other networks that support CAMEL

CSE:-CAMEL Service Environment

Capacity:-A measure of a cellular network's ability to support simultaneous calls

CB:-Cell Broadcast

CC:-Call Control; manages call connections

CCB:-Customer Care and Billing

CCCH:-Common Control Channels; a group of uplink and downlink channels between the MS and the BTS (see PCH, AGCH and RACH)

CCS7:-Common Channel Signalling No. 7

CDMA:-Code Division Multiple Access; also known as spread spectrum, CDMA cellular systems utilise a single frequency band for all traffic, differentiating the individual transmissions by assigning them unique codes before transmission.

CDMAone:-The first commercial CDMA cellular system; deployed in North America and Korea; also known as IS-95

CDMA2000:-A member of the IMT-2000 3G family; backwardly compatible with cdmaOne

CDMA 1X:-The first generation of cdma2000; the standardisation process indicated that there would be CDMA 2X and CDMA 3X but this no longer appears likely

CDMA 1X EV-DO:-A variant of CDMA 1X which delivers data only

CDPD:-Cellular Digital Packet Data; a packet switched data service largely deployed in the USA. The service uses idle analogue channels to carry the packetised information.

CDPSK:-Coherent Differential Phase Shift Keying

CDR:-Call Detail Records; the record made within the cellular network of all details of both incoming and outgoing calls made by subscribers, The CDR is passed to the billing system for action

Cell:-The area covered by a cellular base station. A cell site may sectorise its antennas to service several cells from one location Cell site. The facility housing the transmitters/receivers, the antennas and associated equipment

Cell splitting:-The process of converting a single cell to multiple cells by sectorising the antennas in the cell site or constructing additional cells within a cell site

CELP:-Code Excited Linear Prediction; an analogue to digital voice coding scheme, there are a number of variants used in cellular systems

CEPT:-Conference of European Posts and Telecommunications. A organisation of national posts, telegraphs and telephone administrations. Until 1988, when this work was take over by ETSI, the main European body for telecommunications standardisation. CEPT established the original GSM standardisation group

CF:-Call Forwarding

CI:-Carrier to Interference ratio

CIBER:-Cellular Intercarrier Billing Exchange Roamer Record

CID:-Caller Identification

Circuit switching:-A method used in telecommunications where a temporary dedicated circuit of constant bandwidth is established between two distant endpoints in a network. Mainly used for voice traffic; the opposite of packet switching

CLID:-Calling Line Identification

CLIP:-Calling Line Identification Presentation

CLIR:-Calling Line Identification Restriction

CM:-Connection Management; is used to set up, maintain and take down call connections

CMOS:-Complementary Metal Oxide Substrate

Codec:-A word formed by combining coder and decoder the codec is a device which encodes and decodes signals. The voice codec in a cellular network converts voice signals into and back from bit strings. In GSM networks, in addition to the standard voice codec, it is possible to implement Half Rate (HR) codecs and Enhanced Full Rate (EFR) codecs

Control signal:-A signal sent to a cellular phone from a base station or vice versa which carries information essential to the call but not including the audio portion of a conversation

CPE:-Customer Premises Equipment; all the equipment on the end user's side of the network interface

CPU:-Central Processing Unit

CRC:-Cyclic Redundancy Check

CRM:-Customer Relationship Management

CSS:-Customer Support System

CT:-Cordless Telephone

CT0:-Zero generation cordless telephony; the earliest domestic cordless phones which used analogue technology and which had severe limitations in terms of range and security

CT1:-First generation cordless telephony; Improved analogue phones with greater range and security; a number of European nations produced CT1 standards

CT2:-Second generation cordless telephony; Using digital technology CT2 phones offered greater range, improved security and a wide range of new functionalities

CT2-CAI:-Second generation cordless telephony-common air interface

CTA:-Cordless Terminal Adaptor

CTM:-Cordless Terminal Mobility

CTR:-Common Technical Regulation; part of the ETSI standardisation process

CUG:-Closed User Group

D/A:-Digital to Analogue conversion

DAC:-Digital to Analogue Convertor

DAMA:-Demand Assigned Multiple Access

D-AMPS:-Digital AMPS, a US wireless standard also known as IS-136

DAN:-DECT Access Node

DCA:-Dynamic Channel Assignment

DCCH:-Dedicated Control Channels; responsible for roaming, handovers, encryption etc

DCE:-Data Communications Equipment

DCH:-Data Clearing House

DCPSK:-Differentially Coherent Phase Shift Keying

DCS1800:-Digital Cellular System at 1800MHz, now known as GSM1800

DECT:-Digitally Enhanced Cordless Telecommunications system, a second generation digital cordless technology standardised by ETSI

DEPSK:-Differential Encoded Phase Shift Keying

DES:-Digital Encryption Standard

DFSK:-Double Frequency Shift Keying

Digital:-a method of representing information as numbers with discrete values; usually expressed as a sequence of bits

DPCM:-Differential Pulse Code Modulation

DPSK:-Digital Phase Shift Keying

DQPSK:-Digital Quadrature Phase Shift Keying

DS-CDMA:-Direct Sequence CDMA

DSP:-Digital Signal Processing

DSRR:-Digital Short Range Radio; a UK standard for a low power, short range radio system designed for small voice and data networks

DTE:-Data Terminal Equipment

DTMF:-Dual Tone MultiFrequency; better know as Touch Tone. The tones generated by touching the keys on the phone are used for a variety of purposes including voice mail systems and voice messaging

DTX:-Discontinuous Transmission

Dual Band:-The capability of GSM infrastructure elements and handsets to work across both the 900MHz and 1800MHz bands. The capability to seamlessly handover between the two bands offers operators major capacity gains

DB:-Dummy Burst; transmitted as a filler in unused timeslots of the carrier

Duplex:-The wireless technique where one frequency band is used for traffic from the network to the subscriber (the downlink) and another, widely separated, band is used for traffic from the subscriber to the network (the uplink)

EDGE:-Enhanced Data rates for GSM Evolution; effectively the final stage in the evolution of the GSM standard, EDGE uses a new modulation schema to enable theoretical data speeds of up to 384kbit/s within the existing GSM spectrum. An alternative upgrade path towards 3G services for operators, such as those in the USA, without access to new spectrum. Also known as Enhanced GPRS (E-GPRS)

EEPROM:-Electrically Erasable Programmable Read Only Memory

EFR:-Enhanced Full Rate; a alternative voice codec that provides improved voice quality in a GSM network (see codec)

EFT:-Electronic Funds Transfer

EGSM:-Extended (frequency range) GSM

EIR:-Equipment Identity Register; a database that contains a list of all valid mobile stations within a network based on their IMEI

EIRP:-Effective Isotropic Radiated Power

EPROM:-Erasable Programmable Read Only Memory

Erlang:-A dimensionless unit of average traffic density in a telecommunications network

ERMES:-Enhanced Radio Messaging System; a paging technology developed by ETSI which was intended to allow users to roam throughout Europe. Adopted by a number of European and Middle Eastern countries, ERMES, like paging in general, was overtaken by the ubiquity of GSM

ERO:-European Radiocommunications Office

ERP:-Effective Radiated Power

ESMR:-Enhanced Special Mobile Radio

ESN:-Electronic Serial Number; a 32-bit number that uniquely identifies a mobile phone

ESPRIT:-European Strategic Programme for Research and Development in Information Technology

ETACS:-Extended TACS; the extension of TACS by the addition of new frequencies

ETS:-European Telecommunications Standard

ETSI:-European Telecommunications Standards Institute: The European group responsible for defining telecommunications standards

FACCH:-Fast Associated Control Channel

FB:-Frequency Correction Burst; used for frequency synchronisation of the mobile

FCC:-Federal Communications Commission; the US regulatory body for telecommunications

FCCH:-Frequency Correction Channel; downlink only, correction of MS frequencies, transmission of frequency standard to MS etc.

FDD:-Frequency Division Duplex; a radio technique which uses paired spectrum; UMTS has an FDD element

FDMA :-Frequency Division Multiple Access-a transmission technique where the assigned frequency band for a network is divided into sub-bands which are allocated to a subscriber for the duration of their calls

FEC:-Forward Error Correction

FH:-Frequency Hopping

FH-CDMA:-Frequency Hopping CDMA

FMC:-Fixed Mobile Convergence

FMI:-Fixed Mobile Integration

FPLMTS:-Future Public Land Mobile Telecommunications System, the original title of the ITU's third generation concept now known as IMT-2000

FRA:-Fixed Radio Access

FSDPSK:-Filtered Symmetric Differential Phase Shift Keying

FSK:-Frequency Shift Keying; a method of using frequency modulation to send digital information

FSOQ:-Frequency Shift Offset Quadrature Modulation

FSS :-Fixed Satellite Service

Gb:-The interface between the PCU and the SGSN in a GSM/GPRS network

Gc:-The interface between the GGSN and the HLR in a GSM/GPRS network

Gd:-The interface between the SGSN and the SMSC in a GSM/GPRS network

Gf:-The interface between the SGSN and the EIR in a GSM/GPRS network

Gi:-The interface between the GGSN and the Internet in a GPRS network

Gn:-The interface between the GGSN and the SGSN in a GPRS network

Gp:-The interfaces between the GGSN/SGSN and the Border Gateway in a GPRS network

Gr:-The interface between the SGSN and the HLR in a GPRS network

Gs:-The interface between the SGSN and the MSC in a GSM/GPRS network

GAIT:-GSM/ANSI 136 Interoperability Committee

GAP:-Generic Access Profile

Gbit/s:-A unit of data transmission rate equal to one billion bits per second

GMSC:-Gateway Mobile Services Switching Centre; the gateway between two networks

GCF:-Global Certification Forum

Geostationary:-Refers to a satellite in equatorial orbit above the earth which appears from the surface to be stationary

GERAN:-GSM-EDGE Radio Access Network; the name for the evolution of GSM towards 3G based on EDGE

GGRF:-GSM Global Roaming Forum

GGSN:-Gateway GPRS Support Node; the gateway between a cellular network and a IP network.

GHz:-A unit of frequency equal to one billion Hertz per second

GMPCS:-Global Mobile Personal Communications by Satellite

GMSK:-Gaussian filtered Minimum Shift Keying

GPRS:-General Packet Radio Service

GPS :-Global Positioning System

GRX:-GPRS Roaming Exchange

GSM:-Global System for Mobile communications, the second generation digital technology originally developed for Europe but which now has in excess of 71 per cent of the world market. Initially developed for operation in the 900MHz band and subsequently modified for the 850, 1800 and 1900MHz bands. GSM originally stood for Groupe Speciale Mobile, the CEPT committee which began the GSM standardisation process

GSM MoU:-The GSM Memorandum of Understanding, an agreement signed between all the major European operators to work together to promote GSM

GSM-R:-GSM-Railway, A variant of GSM designed to meet the special communications needs of international train operators

Handoff:-The transfer of control of a cellular phone call in progress from one cell to another, without any discontinuity

Hands-free:-The operation of a cellular phone without using the handset; usually installed in vehicles.

HCS:-Hierarchical Cell Structure; the architecture of a multi-layered cellular network where subscribers are handed over from the macro to the micro to the pico layer depending on the current network capacity and the needs of the subscriber

HDLC:-High level Data Link Control

HIPERLAN:-High Performance Radio Local Access Network; a wireless local area network being standardised by ETSI (Also HIPERLAN2

HLR:-Home Location Register; the database within a GSM network which stores all the subscriber data. An important element in the roaming process

HSCSD:-High Speed Circuit Switched Data

HSPSD:-High Speed Packet Switched Data

I-ETS:-Interim European Telecommunications Standard

I-mode:-A service developed by Japanese operator NTT DoCoMo, I-mode delivers a huge range of services to subscribers and has proved enormously popular with some 30 million regular users. The revenue sharing model used for I-mode is being adopted by other operators as the basis for the new services enabled by GPRS and 3G

IMEI:-International Mobile Equipment Identity

IMSI:-International Mobile Subscriber Identity; an internal subscriber identity used only by the network

IMT-2000:-The family of third generation technologies approved by the ITU. There are five members of the family: IMT-DS, a direct sequence WCDMA FDD solution IMT-TC, a WCDMA TDD solution IMT-MC, a multicarrier solution developed from cdma2000 IMT-SC, a single carrier solution developed from IS-136/UWC-136 IMT-FT, a TDMA/TDD solution derived from DECT

IN:-Intelligent Network

INAP:-Intelligent Network Application Part

Internet:-A loose confederation of autonomous databases and networks. Originally developed for academic use the Internet is now a global structure of millions of sites accessible by anyone

Intranet:-A private network which utilises the same techniques as the Internet but is accessible only by authorised users

IP:-Internet Protocol

IPR:-Intellectual Property Rights

IPv6:-The next generation of IP addressing designed to replace the current system IPv4 which uses a 32 bit address code which limits the number of possible addresses. IPv6 uses a 128 bit code ensuring that the possible number of IP addresses will be virtually limitless

IrDA:-Infra red Data Association

Iridium:-A low earth orbit satellite communications system developed initially by Motorola.

IS-54:-The first evolution in the USA from analogue to digital technology. Used a hybrid of analogue and digital technology, superseded by IS-136

IS-95:-Cellular standard know also as cdmaOne

IS-136:-Cellular standard also known as TDMA or D-AMPS

ISDN:-Integrated Services Digital Network

ISO:-International Standards Organisation

ISP :-Internet Service Provider

ITU:-International Telecommunications Union

ITU-R:-ITU Telecommunications Radio Sector

ITU-T:-ITU Telecommunications Standardisation Sector

IWF:-Interworking Function

Java:-A programming language developed by Sun Microsystems Java is characterised by the fact that programs written in Java do not rely on an operating system

JPEG:-Joint Photographic Experts Group

LAN:-Local Area Network

LANS:-Local Area Network Service

LAP:-Link Access Protocol

LEO:-Low Earth Orbit; refers to satellites which orbit the Earth at around 1,000 kilometres

LMSS:-Land Mobile Satellite Service

LOS:-Line of Sight

MAC:-Media Access Control; the lower sublayer of the OSI system

MAN:-Metropolitan Area Network

MAP:-Mobile Application Part

Mbit/s :-Megabit: a unit of data transmission speed equal to one million bits per second

MHz:-Megahertz; a unit of frequency equal to one million Hertz

MCPA:-Multi Carrier Power Amplifier

MeXe:-Mobile Execution Environment; likely to be based on Java, MeXe enables WAP-enabled devices to offer a wider range of features with greater security and flexibility, as well as greater control of telephony features

MFSK:-Multiple Frequency Shift Keying

MMI:-Man Machine Interface

MMS:-Multimedia Messaging Service; an evolution of SMS, MMS goes beyond text messaging offering various kinds of multimedia content including images, audio and video clips

MMSK:-Modified Minimum Shift Keying

MNO:-Mobile Network Operator

Modulation:-The process of imposing an information signal on a carrier. This can be done by changing the amplitude (AM), the frequency (FM) or the phase, or any combination of these

MoU:-Memorandum of Understanding

MPEG:-Motion Picture Experts Group; MPEG4 is a technology for compressing voice and video so that the information can be transmitted over normally difficult links such as mobile radio

MS:-Mobile Station

MSC:-Mobile Switching Centre; the switching centre of a mobile phone network, the MSC has interfaces to the BSCs, HLR, VLR and other MSCs

MSISDN:-Mobile Station International ISDN Number

MSK :-Minimum Shift Keying; Another term for FFSK

Multiplexing:-A telecommunications technique where several channels can be combined to share the same transmission medium. The most common forms are Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM)

MVPN:-Mobile Virtual Private Network

N-AMPS:-Narrowband AMPS

NB:-Normal Burst; used to carry traffic and control channels

NMT:-Nordic Mobile Telephone system

OTA:-Over the air activation (of services and tariff changes)

O&M:-Operations and Maintenance

OMC:-Operations and Maintenance Centre

OMC-R:-The radio OMC

OMC-S:-The switching OMC

OSI:-Open Systems Interconnection; a seven layer model for protocols defined by ISO

PACS:-Personal Access Communication System; a digital cordless technology developed initially by Bell Labs in the US, PACS was designed to compete with DECT

Packet switching:-A communication system wherein the information is transmitted in packets of a set size. These packets have address headers and find their way to their destination by the most efficient route through the network. Compared to circuit switching where a connection is occupied until the traffic exchange is completed, packet switching offers considerable efficiencies as connections can be used by a number of users simultaneously

PAMR:-Public Access Mobile Radio; Commercial service using trunking techniques in which multiple groups of users can set up their own closed systems within a shared public network

PAP:-Public Access Profile; a DECT term

PCH:-Paging Channel; downlink only, the MS is informed of incoming calls by the BTS via the PCH

PCM:-Pulse Code Modulation; the standard digital voice format at 64kbit/s

PCMCIA:-Personal Computer Memory Card Interface Association the body responsible for defining the standards and formats for memory expansion cards for laptop computers and PDAs. Now extended to cover cards for mobile phones

PCN:-Personal Communications Network; a designation initially used in the UK to refer to networks operating in the 1800MHz band (see also DCS1800). No longer in use

PCS 1900:-Personal Communications Systems 1900MHz; the terminology used in the US to describe the new digital networks being deployed in the 1900MHz band; rarely used today

PCU:-Packet Control Unit; an element in a GPRS/UMTS network

PDA:-Personal Digital Assistant

PDC:-Personal Digital Communications; a digital cellular technology developed and deployed uniquely in Japan. A TDMA technology, PDC is incompatible with any other digital cellular standard

PEDC:-Pan European Digital Communications; A designation occasionally used in the early 1990's to describe GSM. No longer in use

Penetration:-The percentage of the total population which owns a mobile phone

PHS / PHP:-Personal Handy Phone System/Phone

PIN:-Personal Identifier Number

PKI:-Public Key Infrastructure

PLMN:-Public Land Mobile Network; any cellular operator's netw

PMR:-Private Mobile Radio communications

POCSAG:-Post Office Code Standardisation Group

PoP:-Points of Presence; a method of measuring the value of a cellular licence; the approximate number of potential customers within a geographical area

POTS:-Plain Old Telephone Service

PROM:-Programmable Read Only Memor

PSK:-Phase Shift Keying

PSRCP:-Public Safety Radio Communications Project

PSDN:-Public Switched Data Network

PSPDN:-Public Switched Packet Data Network

PSTN:-Public Switched Telephone Network

PSU:-Power Supply Unit

PTO:-Public Telecommunication Operator

PTT:-Posts, Telephone and Telegraph Administration

PTT:-Push-to-Talk

PWT:-Personal Wireless Telecommunications

QAM:-Quadrature Amplitude Modulation

QAPSK:-Quadrature Amplitude Phase Shift Keying

QCELP:-Quadrature Code Excited Linear Prediction

QoS:-Quality of Service

QPSK:-Quadrature Phase Shift Keying

RACE:-Research in Advanced Communications in Europe

RACH:-Random Access Channel

RAM:-Random Access Memory

RFP:-Radio Fixed Part; equivalent to a base station in a DECT system

RCC:-Radio Common Carrier

RP :-Radio Part

RNC:-Radio Network Controller

Roaming:-A service unique to GSM which enables a subscriber to make and receive calls when outside the service area of his home network e.g. when travelling abroad

Router :-A device which forwards information in a network on a connectionless basis

RRM:-Radio Resource Management, part of the UMTS infrastructure

RT:-Remote Terminal

SACCH:-Slow Associated Control Channel

SAR:-Specific Absorption Rate

SB:-Synchronisation Burst; used for time synchronisation of the mobile

S-CDMA:-Synchronous CDMA

SCH:-Synchronisation Channel

SCP:-Switching/Service Control Point

SDCCH:-Stand-alone Dedicated Control Channel; communications channel between the MS and the BTS. Used for signalling during call set-up before a TCH is allocated

SDLC:-Synchronous Data Link Control

SDMA:-Spatial Division Multiple Access

SGSN:-Serving GPRS Support Node

SIM:-Subscriber Identity Module; A smart card containing the telephone number of the subscriber, encoded network identification details, the PIN and other user data such as the phone book. A user's SIM card can be moved from phone to phone as it contains all the key information required to activate the phone

SoHo:-Small Office/Home Office

Streaming:-An Internet derived expression for the one-way transmission of video and audio content

STK:-SIM ToolKi

SMR:-Specialised Mobile Radio

SMS:-Short Message Service; a text message service which enables users to send short messages (160 characters) to other users. A very popular service, particularly amongst young people, with 400 billion SMS messages sent worldwide in 2002

SMSC:-SMS Centre-the network entity which switches SMS traffic

SMSCB:-SMS Cell Broadcast

SMS-MO:-SMS Mobile Originated

SMS-MT:-SMS Mobile Terminated

SMS-PP:-SMS Point to Point

SP:-Service Provider

SQAM:-Staggered Quadrature Amplitude Modulation

SQPSK:-Staggered Quadrature Phase Shift Keying

SS:-Supplementary Service Support; handles special services

SS7:-Signalling System Number 7

SSP:-Service Switching Point

STM:-Synchronous Transfer Mode

TACS:-Total Access Communications System

TAP:-Transferred Account Procedure

TBR:-Technical Basis for Regulation (part of the ETSI standardisation process)

TCH:-Traffic Channel

TD-CDMA:-Time Division CDMA

TD-SCDMA:-Time Division-Synchronous CDMA

TDD:-Time Division Duplex

TDMA:-Time Division Multiple Access

TFTS:-Terrestrial Flight Telephone System

TIPHON:-Telecommunications and Internet Protocol Harmonisation over Networks

TMN:-Telecommunications Management Network

TMSI:-Temporary Mobile Subscriber Identity

TRAU:-Transcoder Rate Adapter Unit

Tri-band:-Refers to a mobile phone able to operate on the three internationally designated GSM frequencies- 900, 1800 and 1900MHz

TRX:-Transmitter/receiver (transceiver)

UI:-User Interface

Um:-The air interface between the BTS and the MS in a GSM network

UMTS:-Universal Mobile Telecommunications System

UPN:-Universal Personal Number

UPT:-Universal Personal Telecommunications

URL:-Uniform Resource Locator; the addressing system of the Internet

USO:-Universal Service Obligation

UTRA:-Universal Terrestrial Radio Access

UTRAN:-Universal Terrestrial Radio Access Network

USIM:-Universal Subscriber Identity Module; the 3G equivalent of the GSM SIM

UWB:-Ultra Wide Band

VAS:-Value Added Services

VBR:-Variable Bit Rate

VHE:-Virtual Home Environment

VLR:-Visitor Location Register

Vocoder:-Voice coder

VoIP:-Voice over Internet Protocol

VPN:-Virtual Private Network

VSAT:-Very Small Aperture Terminal

VSELP:-Vector Sum Excited Linear Prediction

WAP:-Wireless Application Protocol

WARC:-World Administration Radio Conference

WCDMA :-Wideband CDMA

WLL:-Wireless Local Loop

WLAN:-Wireless Local Area Network

WML:-Wireless Markup Language; a markup language developed specifically for wireless applications. WML is based on XML

WQAM:-Weighted Quadrature Amplitude Modulation

WWW:-World Wide Web

XML:- Extended Markup Language

Appendix : C

The Consumer Mobile Glossary

Advice of charge:-A service which provides the user with information on the cost of calls from a mobile phone

Airtime:-The amount of time a subscriber spends using his/her mobile phone

Battery status/Battery charge display:-An indication of the amount of battery life remaining

Battery :- A chargeable device which provides the mobile phone with power. A variety of battery technologies have been used for mobile phones including nickel cadmium (NiCad), nickel metal hydride (NiMH) and lithium ion (Li-ion)

Call barring :-A service which enables users to bar certain incoming or outgoing calls on their mobile phones

Call timer:-A service which keeps track of the amount of airtime being used by the subscriber on a cumulative basis

Call divert:-The capability to divert incoming calls to another phone (fixed or mobile) or to an answering service

Call hold :- The ability to put an ongoing call on hold whilst answering or making a second call

Caller ID:-Caller Identification; displays the name/number of the person calling a mobile phone. Also known as CLI

CLI:-See Caller ID

CLR:-Clear; the key on a cellular phone which is pressed to remove information from the display

Data capable:-Mobile phones which have the capability to enable transmission of data from a laptop computer or PDA via the phone

Dual band:-Mobile phones which support transmission and reception of calls on the 900MHz and 1800MHz bands with seamless handover between the two frequency bands

EFR:-Enhanced Full Rate (codec); an improved version of the standard voice codec used in GSM phones; offers improved speech quality without impacting on network capacity

END:-The key on a cellular phone which is pressed to terminate a call

Infrared data port:-A facility on a mobile phone to allow information to be exchanged with other devices e.g. a PC using infra red technology

Lock:-A function on a cellular phone which, when activated, prevents use of the phone until the user enters a security code

No Service:-An indication on the display of a cellular phone that indicates that the user is in an area where cellular service is unavailable

One-touch dialing:-The ability to dial frequently called numbers using a single key stroke; see Speed Dialling

PCN:-Personal Communications Networks; an outdated term for GSM services in the 1800MHz band

PDA:-Personal Digital Assistant; a sophisticated handheld device with advanced display facilities and a range of business-oriented software programs

Phone book:-A list of personal names and numbers stored in a mobile phone's internal memory or in the SIM card. These numbers can be called by accessing the appropriate memory and making a single key stroke

PIN:-Personal Identity Number; a number, usually four digits, that must be keyed into a mobile phone to make it work. A security measure to prevent unauthorised usage

RCL:-The function on a cellular phone which recalls a phone number from memory

Roaming:-The ability to make and receive calls on the same mobile phone when travelling outside the area of the home network operator

Smartphone:-a combination of mobile phone and personal digital assistant

SND:-Send; The key on a cellular phone which initiates a call or answers an incoming call

Speed dialing:-See One-touch dialling

Standby time:-The length of time a battery can power a mobile phone when it is switched on but not making or receiving calls

Talk-time:-The length of time a battery can power a mobile phone when making or receiving calls

Voicemail:-A service offered by network operators whereby calls received when the mobile is in use, switched off or out of coverage can be diverted to an answering service which can be personalised by the user

WAP:-Wireless Application Protocol; a standard whereby mobile phones can gain access to specially tailored Internet websites

WML:-Wireless Markup Language; a specially designed markup language used for tailoring WAP content. WML enables optimum usage of the limited displaycapabilities of the mobile phone.