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Improving Handover in GSM Network

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Abstract

All GSM service provider uses KPI to monitor their QOS performance. Report generated from OMCR terminal & customer feedback are considered in further network improvement activity. Handover is very important QOS .In this paper some practical cases and solutions are adopted to improve the Handover. Major Handover failure reason, call drop, easons and solutions are discussed. drive test tool Ascom TEMS 10.2.1 is used to perform drive test. if optimization done continuously it will attract more and more customers due to service satisfaction.

Index term :- *GSM,RF optimization ,drivetest, TEMS drive test tool, Handover etc.*

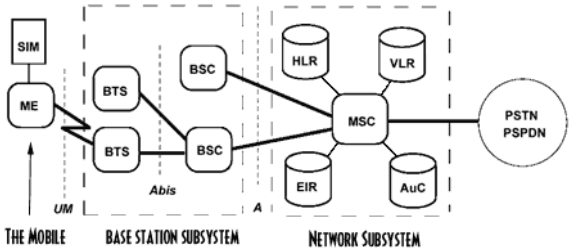
INTRODUCTION

A GSM system is basically designed as a combination of three major subsystems: the network subsystem, the radio subsystem, and the operation support subsystem. In order to ensure that network operators will have several sources of cellular infrastructure equipment, GSM decided to specify not only the air interface, but also the main interfaces that identify different parts. There are three dominant interfaces, namely, an interface between MSC and the base Transceiver Station (BTS), and an Um interface between the BTS and MS.

Every telephone network needs a well-designed structure in order to route incoming called to the correct exchange and finally to the called subscriber. In a mobile network, this structure is of great importance because of the mobility of all its subscribers .In the GSM system, the network is divided into the following partitioned areas.

GSM service area;
PLMN service area;
MSC service area;
Location area;
Cells.

The GSM service is the total area served by the combination of all member countries where a mobile can be serviced. The next level is the PLMN service area. There can be several within a country, based on its size. The links between a GSM/PLMN network and other PSTN, ISDN, or PLMN network will be on the level of international or national transit exchange. All incoming calls for a GSM/PLMN network will be routed to a gateway MSC. A gateway MSC works as an incoming transit exchange for the GSM/PLMN. In a GSM/PLMN network, all mobile-terminated calls will be routed to a gateway MSC. Call connections between PLMNs, or to fixed networks, must be routed through certain designated MSCs called a gateway MSC. The gateway MSC contains the interworking functions to make these connections. They also route incoming calls to the proper MSC within the network. The next level of division is the MSC/VLR service area. In one PLMN there can be several MSC/VLR service area. MSC/VLR is a role controller of calls within its jurisdiction. In order to route a call to a mobile subscriber, the path through links to the MSC in the MSC area where the subscriber is currently located. The mobile location can be uniquely identified since the is registered in a VLR, which is generally associated with an MSC



The next division level is that of the LA's within a MSC/VLR combination. There are several LA's within one MSc/VLR combination. A LA is a part of the MSC/VLR service area in which a MS may move freely without updating location information to the MSC/VLR exchange that control the LA. Within a LA a paging message is broadcast in order to find the called mobile subscriber. The LA can be identified by the system using the Location Area Identity (LAI). The LA is used by the GSM system to search for a subscriber in a active state.

Lastly, a LA is divided into many cells. A cell is an identity served by one BTS. The MS distinguishes between cells using the Base Station Identification code (BSIC) that the cell site broadcast over the air.

HANDOVER MANAGEMENT

The main aim of handover is to avoid losing a call is progress when MS leaves the radio coverage of the call in charge.

Handovers can be classified as

Internal handover within one cell

Internal handover between cells.

External handover.

The hand-over process may be thought of as consisting of three phases-

Recognition that handover is required.

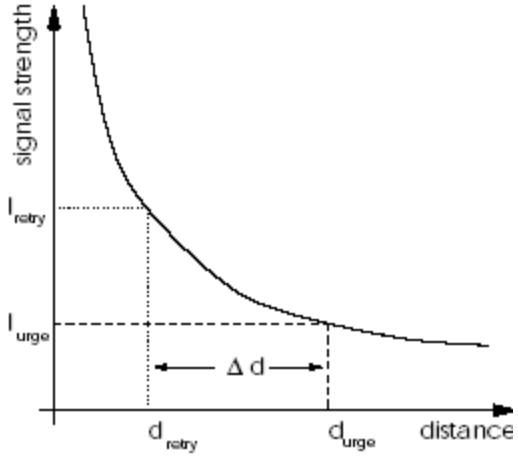
Decision of a target cell.

Execution of the handover.

Allocation and connection of new channel.

Reallocation and release of old channel.

The BSS is wholly responsible for first phase. However MSC may trigger BSS to do so through certain, BSSMAP procedure. MSC participates with BSS in execution of phase 2 and 3.



Type of handovers-

Rescuer handover are done to avoid losing a call in progress when MS leaves the radio coverage area of the cell in charge. These are the most common types of handover. The handover decision is triggered by the averaged measurement reports given by the MS, for the beacon frequencies of the adjacent cells given to it by the BSS.

Confinement handover is an handover triggered with the goal of optimizing the interface level. The BSC divides the frequencies in a cell into five interference bands based on interference level on each of them.

Traffic hand-overs are aimed at reducing the congestion in congested cell by handing over some cell from one cell to less congested one.

The hand-over procedure provides interface between the call control entities, MAP procedure and the BSSMAP procedure to realize the handover. The handover are further categorized into:

Intra MSC handover.

Inter MSC handover.

The intra MSC handover procedure operates as detailed below.

BSS- A generates the HANDOVER REQUIRED message to MSC containing a list of cells in order of preference to which MS is to be hand-over.

MSC on getting this message send a HANDOVER REQUEST message to the target BSS i.e BSS-B.

BSS-B an receiving handover request messages takes all necessary action for giving radio access to the MS in the new cell and gives a HANDOVER REQUEST ACK to MSC with a handover reference number.

The HANDOVER REQUEST ACK message contains a HANDOVER COMMAND message, which is to be transparently passed on by the MSC to BSS-A.
MS now accesses the radio resources of BSS-B with a HADOVER ACCESS on getting which BSS-B verifies the reference number and sends HADOVER DETECT to MSC.
When MS starts successfully communicating with BSS-B,BSS-B sends HANDOVER COMPLETE message to MSC.
MSC now release the resources held on BSS-A by sending it a CLEAR COMMAND.
Note:- When handover procedure is operational all the message meant for the MS are queued up and are delivered only after the handover is complete . In case handover procedure fails the queued up message meant for the MS are delivered once MS is back in communication with the old BSS.

Inter MSC Handover-

Inter MSC handover is required when the target cell belongs to other MSC service area. The successful handover in this case requires a circuit between two MSC's. Inter MSC hand over procedure acquires a circuit between the two MSC's using MAP-E interface.
The handover procedure operates as detailed below-

MSC-A, on receipts of HANDOVER REQUIRED message from BSS-A, sends a MAP_PREPARE_HANDOVER message to MSC-B containing HANDOVER REQUEST message.
On receipts of this message MSC-B acquires a handover number from its VLR and returns it to MSC-A in MAP_PREPARE_HANDOVER_REQUEST_resp. message. This message also contains HANDOVER REQUEST .ACK containing in turn HANDOVER COMMAND to be given by BSS-A to the MS.
On getting this message MSC-A dials handover number to obtain a circuit between two MSC's.MSC-A on receipt of ACM (ISUP) message from MSC-B sends the HANDOVER COMMAND to BSS-A.
MSC-B passes the HANDOVE DETECT and HANDOVER COMPLETE message received from the BSS-B to MSC-A.
After getting HANDOVER COMPLETE from BSS-B over E interface MSC-A initiates the release of radio resources towards BSS-A.

RF OPTIMIZATION & DRIVE TEST

Activity of achieving and maintaining the required quality as designed is RF Optimization. Every live Network needs to be under continues control to maintain/improve the Performance. Optimization is basically the only way to keep track of the network by looking deep into statistics and collecting/analyzing drive test data. It is keeping an eye on its growth and modifying it for the future capacity enhancements. It also helps operation and maintenance for troubleshooting purposes

Objective of RF optimization

To improve the existing network coverage and capacity.
To improve the offered service quality for fulfillment of customer demands.
To maintain the KPIs under pre-defined threshold.
Normally following points are considered in RF optimization
Non–working sites /sectors or TRXs,
Improper function of radio network features like frequency

The quality of the network is ultimately determined by the satisfaction of the users of the network, the subscribers. Drive tests give the 'feel' of the designed network as it is experienced in the field. The testing process starts with selection of the network where the tests need to be performed, and the drive testing path.
Before starting the tests the RF engineer should have the appropriate kits that include TEMS mobile equipment, drive testing software on a laptop, and a GPS (global positioning system) unit. When the drive testing starts, mobile is used to generate calls with a gap of few seconds. It makes one continuous call, and if this call drops it will attempt another call. The purpose of this testing to collect enough samples at a reasonable speed and in a reasonable time. During DT HO failure,RX Level ,speech quality are observed.If there are lots of dropped calls, the problem is analyzed to find a solution for it and to propose changes

In BSNL we are using Ascom TEMS drive test tool kit. OMCR report are taken in consideration before performing the drive test.

Drive Test Route Planning

Primary route(street level) -Includes all major roads, highways and wide thoroughfares-

Secondary route(street level) - Includes all streets, subdivisions and compounds when accessible -

Miscellaneous routes **(**in-building and special locations) Includes golf courses, beach resorts, shopping mails, department stores, convention centers, hotels and resorts

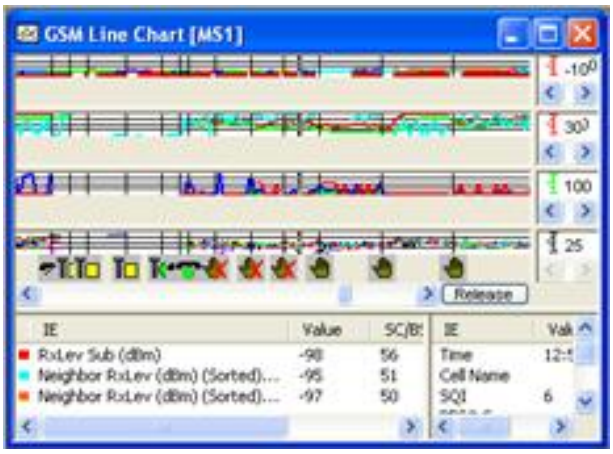
Following & even more windows appears in Drive test .

1. *GSM line chart:-*

Handover success and handover failure report are shown. cross hand shows that handover failure. Handover failure may be due to congestion on neighbor, frequency & neighbor missing. Accordingly Handover are defined.

RX level of serving cell

RX level of Neighbour sites are displayed

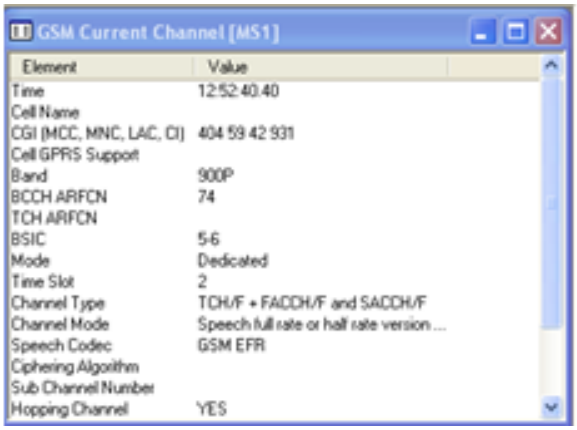


2. GSM current channel:-

In this window cell Id, CGI, BSIC, Hopping, time slot, channel type etc are displayed.

CGI stands for cell global identity CGI = MCC + MNC + LAC + CI (404-59-1125-254)

BSIC stand for Base station identity code



3. GSM Radio parameters:-

In this window RX level, RX quality, BER,SQIC etc are displayed. RX level parameters shows receive level of signal.

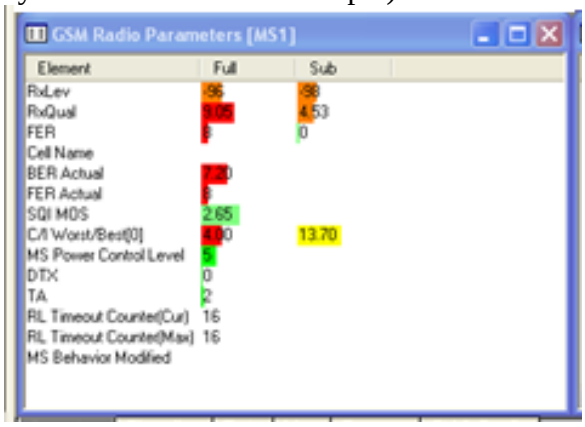
RX level strength colour on screen

> -65dbm Very good strength green colour

-65dbm to -85dbm Good Yellow colour

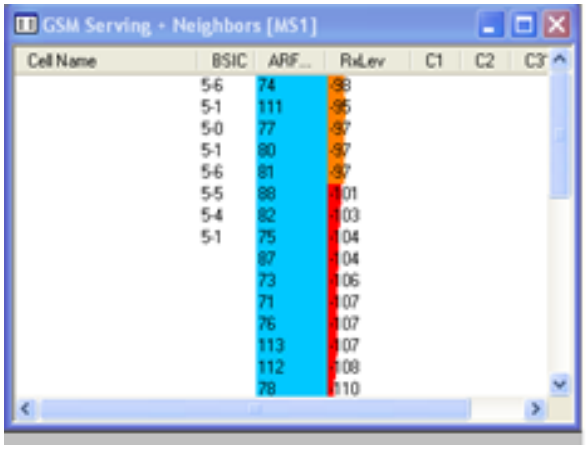
< -85dbm poor Red colour RX quality < 3 good

TA-Timing advance (1 means we are apprx 550m away from tower and in multiple)



4. GSM serving neighgbour:- Cell Name, BSIC,ARFCN ,RX level etc are displayed.

ARFCN –Absolute radio frequency channel number



In addition to above following parameters are also observed
Signal intensity, Signal quality, Interference, Dropped calls, Blocked calls, Anomalous events, Call statistics, Service level statistics, QoS information, Handover information, Neighbouring cell information, GPS location co-ordinates.
Conduct the Drive Test – covering all sectors by observing the following Parameters:
Rx Level
Rx Quality
Interference on BCCH & Hopping Frequencies.
Call setup failure reasons
Observe whether the nearest sector is serving or not.
Drive test report analysis:-
During drive test log file are save during drive test.after completion of drive test these files are processed and result are obtained. Following parameters are
Handove failure, Handove attempt, outgoing call attempt, OG call success, incoming call setup, IC call success etc.

HANDOVER ANALYSIS & FINDINGS

HSR (handover success rate)might be affected and degraded due to following issues:

1) Interference (either external or internal) being observed over air interface, which might affect on going call switching in case of handover.
2) Missing adjacencies can also result in HSR degradation.
3) Hardware faults (such as BTS transceiver) can also be incorporated as a decreasing HSR, which is a part of BSS failures.
4) Location area code (LAC) boundaries wrongly planned and/or defined (where Location area represents a clusterof cells).
5) Coverage limitation is also one of the factors, which decrease HSR values

Analysis & Findings:

Following methods are used to diagnose HSR degradations as well as improvements:

(1)Radio Congestion statistics monitored using radio counter measurement in order to confirm congestion occurrence in a particular cell or area.
(2) Neighboring plans reviewed and adjacencies audits being done.

Following methods are employed in order to improve the HSR in live network:
1) Interference free band i.e., Spectrum analysis might be done to ensure it.
2) Adjacencies audits must be done in order to improve HSR.
3) Coverage improvement is also a vital factor of HSR enhancement.
4) BSS Resources addition (such as TRX) is also a factor for HSR improvement.
5) Parameter modification in OMCR such as Handover margin, traffic handover, power budget parameters to assist better cell handovers
3) Drive Test reports reviewed.

Case. I Handover reversion

Serving Cell	BUN001B	BUN001B	BUN001B
Target Cell	BUN001A	BUN004B	BUN004C
Band of the Target Cell	900	900	900
Relation Type	I	I	I
No. of Handover Attempts	1,512	1,289	1,193
Handover Success (%)	99.34	96.82	33.61
Handover Reversion (%)	0.66	3.03	66.14
Handover Lost (%)	0	0.16	0.25
Ping Pong Handover (%)	32.42	21.63	27.93
Data Availability (%)	100	100	100

BUN001B to BUN004C handover success rate is only 33.61% as 66.14 was handover reversion. Handover reversion does not necessarily lead to a call drop. MS is mostly successful in reverting back to the original cell especially in the case of a Better Cell Handover.

Cell Name	TCH Traffic (Erlang)	TCH drop(%)	Outgoing HO Success Rate
RAW001A	23.53	26.2	68.54
RAW001B	26.9	12.3	57.98
RAW001C	24.54	9.5	52.09
RAW002A	5.17	1	100
RAW002B	2.19	1.5	100
RAW002C	2.54	2.1	97.12
RAW003A	5.9	2.5	77.59
RAW003B	6.73	3.1	87.51
RAW003C	7.47	3.8	87.82

CAUSES OF HANDOVER REVERSION

Co-Channel and Co-BSIC: Measurement result from neighbors can not be distinguished and MS may perform a handover to the wrong cell.

Congestion: High congestion might lead to dragged calls (handover performed at a not intended location) a lot of unsuccessful handover.

Wrong parameter settings : Bad setting might cause the locating will not rank the best cell as a candidate

Uplink interference: Incoming handover failed as the target cell could not decode the handover burst message from the mobile

Suggestion:-

Re frequency planning

Orientation of Antenna for better signal level.

Solutions:-

BCCH frequency changed

Case: II

Customer complain type: Noise, call dropping Continuously, bad sound quality

The orange marked regions where this problem occurred are Rawatbhata exchange (RAW001), the following table I, we can see that the range of traffic of this specific area was (15-30), which is very high. For this reason, handover success rate was very poor (52-70) from the table 1 and the call drop rate was high. From the above KPI data, the range is 9-26.Through this KPI analysis, we got the reason behind call drop. Call drop rate was high because of high congestion and poor handover success rate. Then a drive test has been attempted in RAW001 exchange coverage area for checking the receiving power of signal. We observed that the receiving level of signal in that area is poor. To reduce the congestion and traffic ,adding TRx of each of these sectors might be solution but setup a new BTS would be better solution to solve this problem.

CASE-III

Handover failure, call drop and interference:-

(1) Issue observed:-

Subscriber complain regarding call drop problem of RAW005 site coverage

Steps to resolve issue :-

Check neighbor 2G sites handover – found OK

Check BCCH and BSIC frequency

Drive test report analysis :-

In drive test report analysis it is found that BCCH frequency are same of nearby site

Cell Id	BSIC	BCCH
RAW005A	62	111
RAW006B	68	111

Action taken:-

Change the BCCH frequency planning

CONCLUSION

The overall objectives of any RF design depend on a number of factors that are determined by the needs and expectations of the customer and the resources made available to the customer. Due to the mobility of subscribers and complexity of the radio wave propagation, most of the network problems are caused by increasing subscribers and the changing environment. Handover management in Radio Network Optimization is a continuous process that is required as the network evolves. Radio network optimization is carried out in order to improve the network performance with the existing resources. The main purpose is to increase handover success rate ,the utilization of the network resources, solve the existing and potential problems on the network and identify the probable solutions for future network planning. Through Handover success rate , the service quality and resources usage of the network are greatly improved and the balance among coverage, capacity and quality is achieved.

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