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3g Umts Radio Network Optimsation Using Drive Test and Post Processing Tool

K. Sandeep Rajeev[1], R. Sudheer Babu[2] and Naresh[3]
[1]m.Tech, Communicationand Signal Processing, G. Pulla Reddy Engineering College (Autonomous), Kurnool, Ap.
[2]assistant Professor, Dept. Of Ece, G. Pulla Reddy Engineering College (Autonomous), Kurnool, Ap.
[3]jto, Dept. Of Mobile Communication, Rttc, Bsnl, Hyd, Ap.

Abstract
RF performance parameters such as the received signal strength, Throughput, Channel quality indicator (CQI), pilot pollution etc., are defined for the efficient and effective functioning of the RF network. Also we will measure short-call and long-call control tests from the drive testing process. And this project requires us to work on various tools such as JDSU 16.3 Drive test tool, ACTIX Post processing tool. By analyzing the drive test results, the main motive is to identify problems like less throughput, drop calls, handover failures in any Network like BSNL, Hutch etc., service test area and necessitate steps to improve the throughput, reduce call drops and handover failure rate. How to optimize the Node B coverage area successfully is the real challenge. If the optimization is successfully performed, then the QoS, reliability and availability of RF Coverage area will be highly improved resulting in more customers and more profits to the mobile telecom service providers.
Index terms: MS, TRX, BTS, BSC, MSC, OMCR, CSSR, CDR, HSR, TCH, KPI, CGI and QoS.

I. INTRODUCTION

GSM network usually called as 'cellular network' (as thewhole coverage area is divided into different cells andsectors) is comprised of a mobile Station (MS) which isconnected to the Base Transceiver Station (BTS) via airinterface. In addition to other hardware, BTS contains theequipment called Transceiver (TRX), which is responsiblefor the transmission and reception of several radio frequency(RF) signals to/from the end user.BTS is then connected to the base station controller(BSC) via abis interface. BSC usually handles radioresource management and handovers of the calls from oneBTS (or cell/sector) to the other BTS (or cell/sector)equipped in it. BSC is then connected to Mobile SwitchingCentre (MSC).Before GSM network installation, RF network planning(RNP) teams plan the BTS sites to cover a certain specificarea keeping in view the terrain and population. Moreover,marketing teams also help RNP teams to predict populationand user traffic estimation in the days to come. RNP teamsvisit the areas to be covered and prepare technical sitesurvey reports (TSSR). RNP teams use specific enterprisetools such as MapInfo, ASSETT etc to plan the sites havingdifferent frequency and miscellaneous parameter allocations.Once the sites are planned, the next phase is to acquire therequired land called site acquisition phase. After siteacquisition, engineering teams install BTS sites. RNP teamsalso testify the planned sites with some test parameters andfrequencies to verify their planned parameters and linkbudgets etc. such as signal level, signal quality, speechquality, path balance, path loss, call connectivity and so on.To cater the subscriber demand, RF optimization teamsensure minimum blocking/congestion over air interface in order to provide better QoS to guarantee significant networkperformance.RF Optimization teams used to analyze Performance statsand evaluate QoS offered by the existing network. Since the deployment of GSM network, it has been observedpractically that there are many phenomena and issues whichhave been neglected in literature/available text but theyseverely influence the network performance.

II. EVALUATION CRITERIA

GSM network performance and QoS evaluation are themost important steps for the mobile operators as the revenueand customer satisfaction is directly related to networkperformance and quality. Radio frequency networkoptimization (RNO) teams play a very significant and vitalrole in optimizing an operational network to meet the everincreasingdemands from the end users.
Usually the following tasks are assigned to RNO teams:

1) To improve the existing network coverage and capacity.
2) To improve the offered service quality for fulfillment ofcustomer demands.
3) To maintain the KPIs under pre-defined threshold.

4) To sustain the QoS criteria being imposed by country'sregulatory authority.
5) To standardize and benchmark the network performancewith that of competitor'snetwork to attract more customers keeping a balance between cost and quality.
6) To effectively reuse the available bandwidth andfrequency carriers in order to avoid internalinterferenceand service degradation.

III. PERFORMANCE EVALUATION

GSM Network service providers analyze the networkperformance and evaluate service quality indicators. Theseindicators can be used for the following mentionedpurposes:

1) To identify and locate BSS (hardware) occasional faultsto ensure physical resource availability.
2) To help RF tuning teams to analyze the radio situation, detect radio network problems in one or more BTS andfinally devise a way to optimize the network and adoptcorrective actions like new frequency allocations,antenna tilt adjustment, and parameter modification inOMCR database etc.
3) To monitor system behavior and variance in terms oftraffic load, congestion, successful attempts etc.
4) To predict the upcoming traffic evolution and networkexpansions as per increasing number of mobile users.
5) To benchmark network with another competitor'snetwork to attract more users at the cost of betterquality.

IV. PERFORMANCE EVALUATION FLOW

Usually the network performance and indicators are badlyaffected due to wrong site integrations especially in terms ofdefinition and parameter point of view. Following are therequirements of optimization in terms of networkoperation:

1) Frequency allocation Plan
2) Broadcast control channel (BCCH) Plan
3) Neighboring cells Plan
4) Interference (C/I, C/A) values
5) Best Server Plots
6) Site Audit Reports

In order to be capable to measure the networkperformance, the patterns of a normal day should beconsidered, while for performance evaluation congestionsituations should also be analyzed. Following KPIs aremore important for GSM radio network optimization &benchmarking to achieve remarkable QoS:

1) CSSR (Call Set up Success Rate).
2) CDR (Call Drop Rate).
3) HSR (Handover Success Rate).
4) TCH (Traffic Channel) Congestion Rate.
5) RX Level. (Ec/No)
6) RX Quality. (RSCP)

V. CALL ORIGINATION PROCEDURE

Call origination process has been briefly mentioned herefrom counters perspective.

Step1: Channel Request or demand sent to BTS by MS inorder to set up a call. BTS then forwards the request to BSC.A counter activates in BSC upon receiving channel requestfrom MS in a cell/BTS.

Step2: BSC sends the channel activation command to MSthrough BTS. Another counter activates here in order tocount the channel allocation in a cell/BTS.

Step3: After the channel allocation, call initiates afternecessary authentication from core/MSC end. Once the callconnected, another counter starts in order to count theabnormal call drop or failures (due to BSS or radio linkproblems).

VI. KPI ASSESSMENT& QOS ESTIMATION

In order to understand how the behavior of traffic channels (TCH) and control channels (SDCCH) affects the network's performance, one has to analyze TCH and SDCCH blockingwhen congestion in the network increases. The above mentioned KPIs are frequently used in performancejudgment and QoS estimation of the network.

1. CALL SET-UP SUCCESS RATE (CSSR)
Indicator CSSR
Definition Rate of call attempts until TCH successfulassignment.
Formula Number of successful seizure of SD channel by Total number of requests for seizure of SDchannel.
Result = [(CT01+CT02)/CT03]*100
Condition Applied

Where counter CT01 counts SD channelssuccessfully seized for Call termination &CT02 counts SD channels successfully seizedfor Call origination.CT03 counts SD seizure requests.Where SD (usually called SDCCH stands for Stand-alonededicated control channel) and TCH stands for Trafficchannel. A number of issues are related for its degradationas addressed below.

a) Issues Observed:

CSSR might be affected and degraded due to followingissues:

1) Due to radio interface congestion.
2) Due to lack of radio resources allocation (for instance:SDCCH).
3) Increase in radio traffic in inbound network.
4) Faulty BSS Hardware.
5) Access network Transmission limitations (For instance:abis expansion restrictions)

b) Analysis & Findings:

Following methods are used to diagnose CSSRdegradations as well as improvements:
1) Radio link Congestion statistics monitored using radiocounter measurement.
2) Drive Test Reports.
3) Customer complaints related to block calls have beenreviewed.

c)Improvement Methodologies:

Following measures significantly improve the CSSR inlive network:
1) Radio Resources enhancement (Parametermodification/changes in BSS/OMCR) such as half rate,traffic load sharing and direct retry parametersimplementation.
2) Transmission media Expansion to enhance hardwareadditions (such as TRX).
3) Faulty Hardware Replacement (such as TRX) in orderto ensure the resources availability in live network

2. CALL DROP RATE (CDR)
Indicator CDR
Definition Rate of calls not completed successfully.
Formula Number of TCH drops after assignment by Total number of TCH assignments.
Result =[(CT04+CT05)/CT06]*100

ConditionApplied

Where CT04 counts TCH drops due to radiointerface problems & CT05 counts TCHdrops due to BSS problems. CT06 countsnumbers of TCH successfullyseized/assigned.A number of issues are associated to its degradation asdemonstrated below.

a)Issues Observed:

CDR might be affected due to following issues:
1) Interference (either external or internal) being observedover air interface. Internal interference corresponds toin-band (900/1800 MHz) while external interferencecorresponds to other wireless (usually military) networks.
2) Coverage limitation is also one of the factors, whichincrease CDR values.
3) Hardware faults (such as BTS transceiver) can also beincorporated in an increasing CDR, which is a part ofBSS failures.
4) Missing adjacencies (definition in BSS/OMCR) is alsoan important factor in CDR values increment.

b)Analysis & Findings:

Following methods are used to diagnose the rise in CDRvalues:
1) Radio uplink statistics monitored using radio countermeasurement in order to confirm any uplinkinterference.
2) Path Balance stats which depict average of 'ERP-RXPower' (where 'ERP' stands for effective radiatedpower over downlink and 'RX' stands for receivepower over uplink) also divert attention towards faultyTransceivers hardware.
3) Customer complaints related to block calls would havebeen reviewed.
4) Interference band / Spectrum scanners are also useful infinding and tracing the contaminated frequency carriers resulting in increasing CDR.
5) Drive Test Reports.

c)Improvement Methodologies:

Following are some methods in order to improve theCDR value up to certain pre-Defined baseline:
1) Faulty Hardware Replacement in order to ensure theresources availability in live network.
2) Frequency plans review and model tuning in order toensure the clean band carriers for serving cells. Forinstance; band conversion is done from 900 to 1800MHZ in order to cater uplink interference. Sometimesconcentric cells (multi band cell having GSM & DCStransceivers) solution is also devised.
3) New site integration is also suggested in order toimprove indoor and outdoor coverage, which is usuallytermed as "Grid Enhancement".
4) Sometimes RF repeaters are also used in order toamplify the radio signal to extend coverage area.
5) Existing coverage optimization might be done usingphysical optimization techniques.
6) Parameter tuning can also be done to improve callsustainability. This is done using OMCR terminal. ForInstance Power control parameters. Decrease emittedpower when signal receive level and quality (measuredby peer entity) are better than a given value and viceversa.
7) Frequency hopping technique is also incorporated tominimize the effect of interference.
8) Change of antenna orientation (azimuth/tilt) i.e.,increase the down tilt of interferer cell antenna.

3.HANDOVER SUCCESS RATE (HSR)
Indicator HSR
Definition Rate of successful handovers (intracell +intracell).
Formula No of successful [intercell + intracell] HA1 by Total number of handover requests.
Result =[(CT07+CT08)/(CT09+CT10)] *100
ConditionApplied

Where CT07 counts no. of incomingsuccessful handovers & CT08 counts no. ofoutgoing successful handovers. CT09 countsno. of outgoing HO requests while CT10counts no. of incoming HO requests.A number of issues are related for its degradation asillustrated below:

a)Issues Observed:
HSR might be affected and degraded due to followingissues:
1) Interference (either external or internal) being observedover air interface, which might affect on going callswitching in case of handover.
1) HA stands for Handover Attempts
2)Missing adjacencies can also result in HSR degradation.
3)Hardware faults (such as BTS transceiver) can also beincorporated as a decreasing HSR, which is a part ofBSS failures.
4) Location area code (LAC) boundaries wrongly plannedand/or defined (where Location area represents a clusterof cells).
5) Coverage limitation is also one of the factors, whichdecrease HSR values.

b)Analysis & Findings:
Following methods are used to diagnose HSRdegradations as well as improvements:
1) Radio Congestion statistics monitored using radiocounter measurement in order to confirm congestionoccurrence in a particular cell or area.
2) Neighboring plans reviewed and adjacencies auditsbeing done.
3) Drive Test reports reviewed.

c)Improvement Methodologies:
Following methods are employed in order to improve theHSR in live network:
1) Interference free band i.e., Spectrum analysis might bedone to ensure it.
2) Adjacencies audits must be done in order to improveHSR.
3) Coverage improvement is also a vital factor of HSRenhancement.
4) BSS Resources addition (such as TRX) is also a factorfor HSR improvement.
5) Parameter modification in OMCR such as Handovermargin, traffic handover, power budget parameters toassist better cell handovers.

4.TCH CONGESTION RATE (TCHCR)
Indicator TCH Congestion
Definition Rate of blocked calls due to resourceunavailability
Formula Number of calls blocked due to resource unavailable by Total number of requests.
Result =(CT11 / CT12)*100
ConditionApplied
Where CT11 counts number of assignmentfailures when no TCH available while CT12counts number of normal assignment requestsfor TCH establishment.A number of issues are related for its degradation, whichwould be addressed here.

a) Issues Observed:
TCH (traffic channel) congestion might arise due to following issues:
1) TRX Hardware faults can also be incorporated as anincreasing factor in TCH congestion.
2) Increasing number of subscribers and/or traffic in acertain area also causes congestion.
3) Lesser capacity sites (mainly due to the media issue orhardware resource unavailability) also cause congestionproblems.

b) Analysis & Findings:
Following methods are used to diagnose TCH congestionas well as improvements:
1) Radio Congestion statistics monitored using radiocounter measurement in order to confirm congestionoccurrence in a particular cell or area.
2) Customer complaints can also reveal the issue.
3) Drive Test reports reviewed.
4) WCR (Worst Cell Ratio) and CSSR (Call Set upSuccess Rate) KPIs also depict the TCH congestionproblem.
5) Future subscriber density and growth is also a factor forthe judgment of upcoming congestion.

c) Improvement Methodologies:
Following measures are used to minimize the TCHcongestion in live network:
1) BSS Resources addition and expansion (includingtransceivers and transmission media) are importantfactors for TCH congestion improvement.
2) Faulty hardware maintenance or replacement can alsominimize TCH congestion.
3) Deployment of moving/portable BTS (commonly calledCOW BTS) can be used as a better solution to improvecongestion in case of foreseeable special events such assports events, important meetings, festivals andexhibitions etc.

5. RX LEVEL:
a)Issues Observed:
Low RX level might arise due tofollowing issues:
1)Antenna orientation and tilt
2)High VSWR value
3)TX power

b)Improvement Methodologies:
Following measures are used to minimize the RX Level problems in live network:
1)Physical check of orientation and tilt
2)Check RF connectors and RF cables

3)Check the DRX power and connector

6.RX QUALITY:

a)Issues Observed:

Low RX Quality might arise due tofollowing issues:

1)Interference
2)Low Rx level
3)H/O failure
4)Assignment failure ratio
5)Hardware problem

b)Improvement Methodologies:

Following measures are used to minimize the RX Quality problems in live network:

1)Define proper neighbors
2)Check DRX power and connectors
3)Check BCCH and MAIO frequency
4)Reduction of antenna height, orientation and tilt
5)Check the neighbor list and definition
6)Check the neighbor parameters
7)Check DRX and check VSWR and RF cable connectivity
8)Check DRX hardware

VII. Conclusion & Recommendations

The paper describes simple procedure for cellular networkperformance estimation. In this paper, it has beenanalytically proved that we can optimize an existingcellular network using different methodologies and fineparameter tuning to offer remarkable QoS to the endusers. Moreover, the issues discussed here are quitehelpful for the analysis and performance evaluation ofdifferent cellular networks. Optimization teams use QoSreports in order to detect bad service quality areas.These reports also help to plan operators to enhancecoverage, improve quality and increase capacity in thedays to come. A mobile operator can also set its own QoStargets based on the KPIs in order to ensure end usersatisfaction. QoS reports based on different KPIs are dulybeneficial for Management team to compare networkperformance with the competitor's one (calledbenchmarking) and to plan network evolution andstrategy.

Moreover, it is hereby strongly recommended that allmobile operators must ensure a better QoS up to certainthreshold and baselines in order to satisfy officialregulatory bodies who penalize operators in case ofcustomer complaints regarding service quality.Hence, during radio network planning, it is suggestedto all mobile operators that they must divert attentiontowards better network dimensioning & topology,allocated band scanning, traffic prediction & modeling,network operational expense (OPEX), and networkparameter settings to avoid subsequent issues duringoptimization phase. Secondly, end users require stringentQoS, which compels cellular operators to optimizenetwork performance to meet revenue and commercialtargets as well.

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ABOUT THE AUTHOR:

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