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Root Cause Analysis and New Practical Schemes for better Accessing and Establishing of Dedicated Control Channel in Cellular Networks

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Abstract

The Dedicated Control Channel (DCCH) plays an important role in all generations of cellular networks, such as, GSM1, HSPA2 and LTE3; through this logical channel, some information between user equipment and network can be carried. It should be considered that accessing to the DCCH is the entry gate of entrance to the every cellular network; and without a successful DCCH access call-setup process will not be possible. Hence, DCCH channel accessing is one of the most critical issues that RF4 planner and optimization engineers must consider. More than this, these schemes can contribute to achieve some algorithms in SON5 for ameliorating the DCCH accessing and serving better services at 4G. In this paper, a real fundamentally established cellular network (GSM) is surveyed and its radio frequency network performance is evaluated and presented on the basis of KPI6 parameters in general. Furthermore, the DCCH Access Success in particular and different issues, findings, trials and improvements have been summarized. Also, recommendations have been listed to correlate the practical aspects of RF optimization, which affect the improvement of DCCH Access Success rate in cellular networks.

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Keywords

RF Optimization, BSC7, GSM, BTS8, SDCCH Access Success, KPI, QoS9, LTE, SON.

1. Introduction

This is a general introduction to GSM network optimization procedures. In order to fine tune the network, Link Budget Analysis (LBA) must be done; Frequencies need be analyzed; and RF optimization teams must verify certain parameters such as signal level, signal quality, speech quality, path balance, path loss, call connectivity and so on. To cater the subscriber's demands, RF optimizations teams must try to ensure proper and correct connectivity over the air interface in order to provide better call setup to guarantee significant network performance. One of the most important aspects in every connection via cellular networks is signaling, and hence, signaling is the first step to any effective communication process. Therefore, if accessing to the signaling is successful, it is possible to have a successful call setup. Failure in accessing the signaling will lead to failure in a successful connection. In this paper two real life existing cellular (GSM) networks have been audited. The first network is an Ericsson BSS[10] network containing five BSCs with 420 dual bands, 900 and 1800 MHz, sites, handling approximately 650,000 subscribers were initially connected to a Classical Switch, but later on was replaced by a Soft Switch. The second network is a Nokia BSS network which consists of 11 BSCs and carries nearly 40,000 Erlang. Although, GSM networks have become old-fashioned to survey, but because they are the fundamental and the basis for other networks, they play an important role when analyzing other cellular networks, even new generations. In this paper, firstly, it is attempted to demonstrate the basic structure of GSM networks and signaling, to elaborate on the SDCCH Accessing, to express the relation between KPIs involved by SDCCH, to point out some factors affecting SDCCH accessing, and to represent various solutions and recommendations on BSC and cell level for coping with Low SDCCH Access Success. The aim of this paper is to present and propose almost all solutions for handling SDCCH

1 Global System for Mobile Communication

2 High Speed Packet Access

3 Long Term Evolution

4 Radio Frequency

5 Self-Organizing Network

6 Key Performance Indicators

7 Base Station Controller

8 Base Transceiver Station

9 Quality of Service

10 Base Station Subsystem

access problems and SDCCH Mean Holding Time for improving on SDCCH Drops. It should be highlighted that this topic, in other papers and vendor documents has been touched very briefly without much explanations; however, this paper elaborates on the details and practical schemes for increasing the signaling access. Moreover, from another point of view, there is also more subtle point for dealing with TCH and SDCCH congestion. Finally, it should be brought to your attention that each scheme and result presented in this paper has been carried out in a real condition and in an existing network [8].

2. Basic Structure of a Simple GSM Network

A simple architecture of GSM network is shown in figure 1. The BTS contains the equipment for transmitting and receiving radio signals (transceivers), antennas, and equipment for encrypting/decrypting communications with the BSC. Typically, each BTS has several TRXs[11]which allow it to serve several different frequencies in different sectors of the cell [2]. Figure 1 GSM interfaces such as, Air interface between UE and BTS; A-bis interface between BTS and BSC, Ater interface and A interface between BSC and MSC[12]. The optimization teams usually carry out their investigation activities on the Air interface area; although all other interfaces are equally important in the network performance, but Air-interface is more challenging.

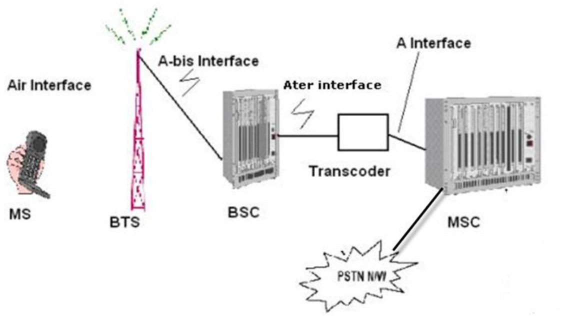

Figure 1: Simple GSM Structure

A successful call set-up consists of two procedures. The first one is the Immediate Assignment procedure which is used to create signaling connection between the UE and the network; and the second one is Assignment procedure which is used to occupy a radio resource (speech channel) [2]. In Air interface, logical channels are divided into two categories: 1- Traffic Channels and 2- Control Channels. The Control Channels are further classified as: "Broadcast", "Common" and "Dedicated" control channels. In figure 2, all logical channels in GSM networks are shown.

Group		Channel	Function
Traffic channel	Traffic channel (TCH)	TCH/F, Bm	Full rate TCH
		TCH/H, Lm	Half rate TCH
Signaling channels (Dm)	Broadcast channel	BCCH	Broadcast control
		FCCH	Frequency correction
		SCH	Synchronization
	Common control channel (CCCH)	RACH	Random access
		AGCH	Access grant
		PCH	Paging
		NCH	Notification
	Dedicated control channel (DCCH)	SDCCH	Stand-alone dedicated control
		SACCH	Slow associated control
		FACCH	Fast associated control

Figure 2: Logical Channels

3. Concept of SDCCH ACCESS SUCCESS

Herein, as the main focus of this paper is on the SDCCH accessing, signaling procedure before and after accessing the SDCCH will be described. The request for SDCCH requires 1- service request, 2- subscriber authentication, 3- equipment validation and 4- assignment to the traffic channel. In GSM's logical channels, the PCH[13]is used to find and address the UE when a call is initiated; this exists only in the direction from BTS to UE. The RACH[14]is used by UE to request channel from the BTS. The AGCH[15]is a downlink only channel used by the network to grant the access request made by the mobile station, and finally SDCCH channel is established. Once the SDCCH is assigned, the ciphering message, authentication massage and other signaling pertaining to the SDCCH are transacted. In figure 2, as you can see, majority of signaling are related to SDCCH.

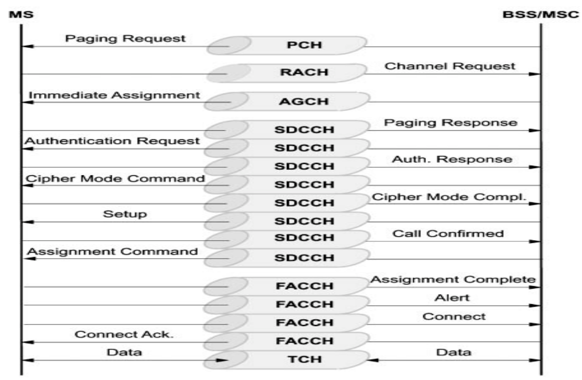

Figure 3: All signaling in one call set-up in GSM

11 Transceiver

12 Mobile Station Center

13 Paging Channel

14 Random Access Channel

15 Access Grant Channel

A successful SDCCH Access is directly proportional to the success of RACH channel access by mobile. From the KPI point of view, SDCCH access success is a percentage of all SDCCH accesses received in the BTS. As you can see in figure 2 and 3, when mobile requests for services from the network, it listens to PCH signal and after receiving the PCH, it sends the RACH signal to the network. If all conditions are suitable, the mobile receives an AGCH signal for assigning the SDCCH channel and finally SDCCH is established. This is called a successful SDCCH access.

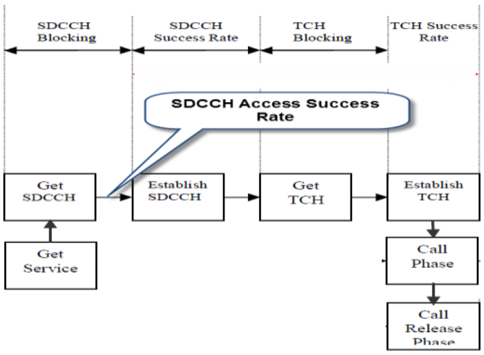

Figure 4: Call Setup process [7]

Definition of SDCCH access success rate is different for various mobile operators, but usually this parameter is defined as per the following formula [1]:

$$\text{SDCCH Access Success} = \text{CMSESTAB} / \text{CCALLS} \quad (1)$$

In (1), CMSESTAB is a counter that stands for the UE connection establishments on the SDCCH. This value increased when signaling link between UE and MSC is established; CCALLS is the allocation attempt counter and this counter is incremented at every attempt to allocate an SDCCH in a resource type in the cell, regardless of whether the allocation has succeeded or has failed [3].

4. Relationship Between SDCCH ACCESS SUCCESS and other KPIs

The SDCCH Access Success has both direct and indirect effects on certain KPIs. These effects and relations have been studied over a period of one month and the results are shown in Figures 5, 6 and 7. In figure 5 and figure 6 we can see these relations for one BSC; and figure 7shows the relation for one cell. These figures demonstrate that we can find correlations between these indicators.

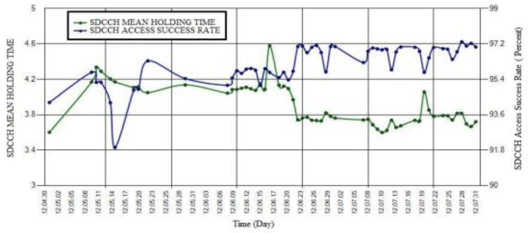

Figure 5: Correlation between SDCCH access success and SDCCH Mean Holding Time in specific BSC

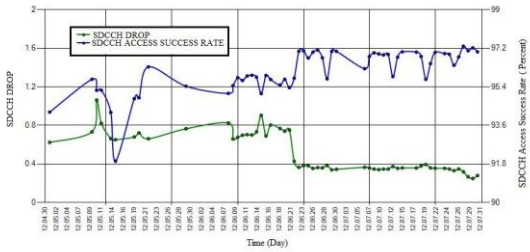

Figure 6: Correlation between SDCCH access success and SDCCH Drop in specific BSC

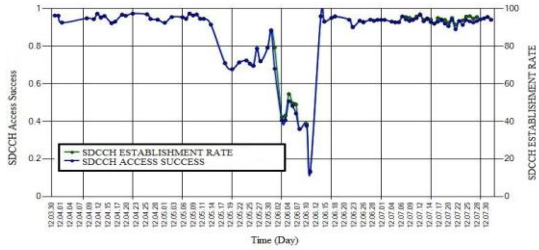

Figure 7: Correlation between SDCCH access success and SDCCH Establishment in specific Cell

As you can see in the above figures, this study clearly shows that SDCCH Drop and SDCCH Mean Holding time have reverse relation with SDCCH Access Success; and direct relation with SDCCH Establishment in case of no congestion. Please note that SDCCH Drop and SDCCH Mean Holding time occur after SDCCH is accessed and established.

5. Degradation of SDCCH Access Success

When some RACHs, spurious emissions (sometimes referred to as phantom RACHs) resembling RACHs, received and decoded by the BSS from a distant mobile request, they will lead to a SDCCH request, which cannot be successfully accessed. After the expiry of BSS timer, the SDCCH resources are de-allocated and returned to the radio resource pool; however, excessive allocation of SDCCH resources to phantom RACHs result in a waste of SDCCH resources and contributes to SDCCH blocking. Another reason which results in low SDCCH Access Success is the weak signal strength; in this case the carrier is not strong enough to contribute to a successful SDCCH connection. Congestion on SDCCH causes bad SDCCH access. The KPIs mentioned in the previous section can help us to have a good vision to reach some methods to enhance the SDCCH Access Success. This can guide us to obtain efficient solutions to improve low SDCCH Access Success. Vice versa, improvement in SDCCH Access Success rate can also improve other related KPIs. This will be discussed with more details in following sections.

SDCCH Access Success [5]

- Too high TA[16]
- Access Burst from another co-channel, co-BSIC cell
- SDCCH Congestion
- False accesses due to high noise floor
- Unknown access causes code.

SDCCH Establishments [4]

- No response to immediate assignment
- The UE does not respond to the immediate assignment due to low Signal Strength (SS)
- High interference
- Random access burst from another co-Channel, co-BSIC[17] cell
- More than one RA[18] Burst send from a mobile during one call setup
- Phantom random access
- BTS hardware or link failure
- Power balance problems.

SDCCH Mean Holding Time [4]

- Congestion on TCH[19]
- Many SMS[20]
- False accesses
- Congestion on signaling routes
- Faulty transceiver.

SDCCH Drop [5]

- Low signal strength on down or uplink
- Poor quality on down or uplink
- Too high Timing Advance
- Congestion on TCH
- Shift the SDCCH time slot
- Hardware issue, TRX condition, connector connection

16 Timing Advance

17 Base Station Identity code

18 Random Access

19 Traffic Channel

20 Short Message

- Interference
- High LAPD[21]utilization.

6. Finding and Recommendation Practical Schemes

Detailed study of the three indicators mentioned in the previous section and some practical schemes have resulted in the following solutions for enhancing network performance,

- Reconfiguring of LAPD
- Traffic balancing in dual band cells (1800 and 900)
- Adjusting the mismatch tilt between main and diversity of one sector in V-Pole[22] antennas
- Avoiding the cell to have overshoot and high TA by tilting
- Reconfiguring of MAXRET[23]parameter
- Changing frequency for coping with the interference
- Changing of RXLEV ACCESS MIN parameter
- Increasing the cell output power
- Increasing the number of SDCCH
- Replacing Mechanical tilt by Electrical tilt
- Removing the hardware failures
- Removing the faulty BTS database
- Modifying of number PDCH[24]
- Immigrating of the MSC from Classical-Switch to the Soft-Switch
- Setting limitation for TA
- Using Cell Load Sharing
- Frequency Re-Planning
- Adding C2 for 1800 band in dual band sites
- Active SDCCH power regulation feature
- Active SDCCH Handovers
- Not use combined BCCH/SDCCH
- Scatter SDCCHs
- Modify the TX-Integer parameter
- Avoiding to Access Burst from another Co-Channel and Co-BSIC cell
- Avoiding network to send numerous SMSs
- Using enable ordinary calls on FACCH
- Changing MS Maximum TX Power
- Modifying BTS measure average (BMA)
- Re-Load of BTS Software

21 Link Access Protocol on the D-channel

22 Vertical polarization

23 Maximum Number of Retransmissions

24 Packet Data Channel

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- Adding Cell Reselect Hysteresis parameter to the edge border cells
- Modifying of Periodic Location Update
- Solving the UNSOLICITED DATA LINK RE-ESTABLISHMENT Alarm
- Removing Extra SDCCHs
- Moving SDCCHs to good Quality TRXs
  All these finding with results will be demonstrated in below respectively.

- **Reconfiguring of LAPD**

LAPD is a protocol used for signaling on the A-bis interface between BSC and BTS. It operates at the data link layer (layer 2) of the OSI[25]architecture. If the LAPD is not configured well, the resources are not allocated properly. In figure 8 the improvement is seen by adjusting this parameter for one site. Both SDCCH and TCH congestions can be coped with by reconfiguring LAPD, and hence the SDCCH Access Success rate has increased.

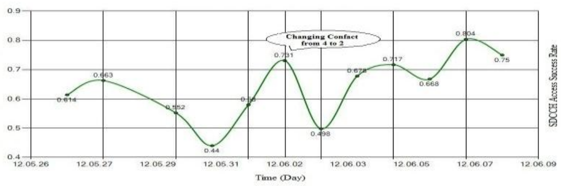

Figure 8: Reconfiguring of LAPD

- **Traffic Balancing in Dual Band Cells (1800 and 900)**

Dual band sectors working in 900MHz and 1800MHz must cover the same area. Traffic balancing is achieved by proper tilt adjustment, otherwise, the traffic is never divided evenly to different bands and sectors will experience TCH and SDCCH Congestion or low SS. As mentioned previously these issues can lead to low SDCCH Access Success rate. Figure 9 shows, the improvement of SDCCH Access Success rate after traffic balancing.

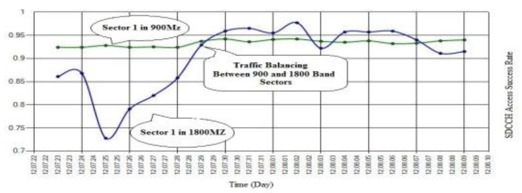

Figure 9: Traffic balancing in dual band cells

- **Adjusting the Mismatch Tilt Between Main and Diversity in V-pole Antennas**

When a cell which uses a V-pole antenna is not adjusted properly, and the two parts of its antenna (Main and Diversity) have different tilts, they will cover various areas. This mismatch can cause the problem of Low SDCCH Access Success rate. Figure 10 clearly shows how SDCCH Access success rate has increased after this adjustment.

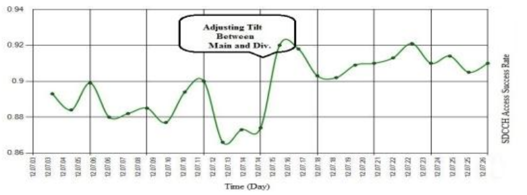

Figure 10: Adjusting the mismatch tilt between main and diversity in V-pole antennas

- **Avoiding the Cell to Have Overshoot and High TA**

One of the most important parameters which affect the SDCCH Access Success is overshooting. In other words, high TA reduces the rate of SDCCH Access Success. Proper tilt adjustment can solve this issue.

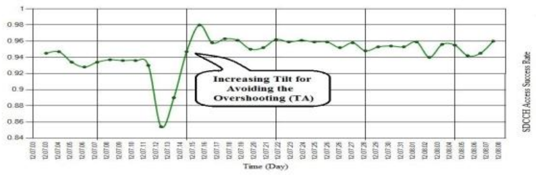

Figure 11: Avoiding the cell to have overshoot and high TA by tilting

- **Reconfiguring of MAXRET Parameter**

The number of times that a UE tries to access the network is decided by the BSS parameter MAXRET. For more than one RA25 burst send from a UE during one call setup, we must check and configure the MAXRET. The response from the BSS to the received RACH from UE can be slow; that is the reason for keeping the number of RACH retransmission low and keeping the repeat intervals slightly longer. By reducing this parameter in a cell, the SDCCH Access Success is improved.

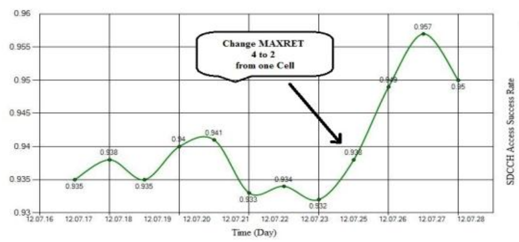

Figure 12: Reconfiguring of MAXRET parameter

- **Changing Frequency for Coping with the Interference**

25 Open Systems Interconnection

Another important condition that affects SDCCH Access Success is interference on TCH and BCCH carriers. When a cell involves with noisy environment, almost all KPIs of that cell will be affected. The following incident was observed during a drive-test: in idle mode, the UE received sufficient signal strength, while in dedicated mode, the signal strength decreased tremendously with poor RX quality, as well as, poor bit error rate and signal per noise ratio. This is a typical case of interference issue. Changing the TCH frequencies or even a complete RF re-planning can take care of this problem.

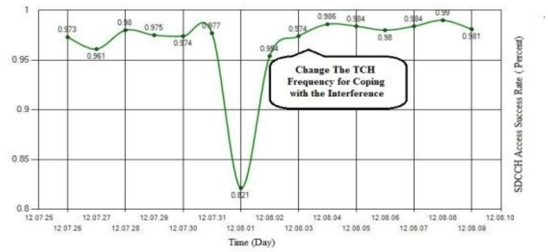

Figure 13: Changing the frequency for coping with the interference

- **Changing of RXLEV ACCESS MIN Parameter**

This parameter specifies the minimum received RX level of a UE for accessing the BSS. By setting this parameter to an appropriate value, the SDCCH Drop can be reduced. It goes without saying that, by this parameter the coverage and accessing the network may become limited. Generally, it is better to set this parameter for urban areas greater that rural or road areas. This means that, in the cities and urban areas the UE must have a good signal level to access the network; this will not cause any issues, because of the density of sites in urban areas.

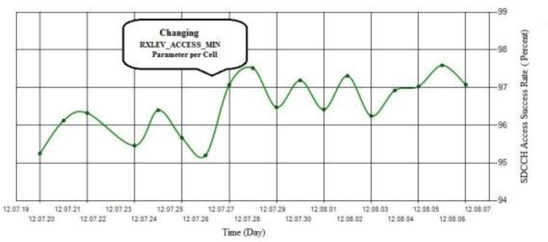

Figure 14: Tuning of RXLEV ACCESS MIN in particular BSC

As we can see in figure 14, the SDCCH Access Success is improved by tuning this parameter. Please note that this case is for a BSC that covers a city located near the sea and majority of its buildings have no basement. Therefore, for each cell, RXLEV ACCESS MIN is set to -98 dBm for 900Mz band and to-95dBm for 1800MZ band. Already by default, this parameter for all cells is set at-102 dBm which means that any UE with -102dBm RX-level would be allowed to reach the network.

- **Increasing the Cell Output Power**

The RX-Level will increase by increasing the signal power. If the RX-Level in a coverage area is sufficient, the signal strength will not be poor; and this factor can help the cellular network to have a decent rate of SDCCH Access Success.

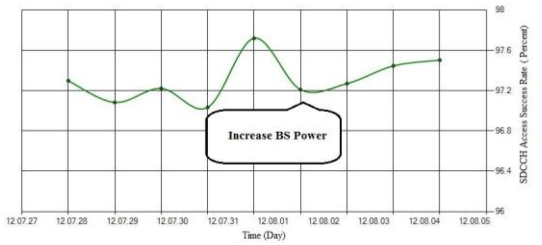

Figure 15: Increasing the Cell Output Power

Figure 15 shows the improvement of SDCCH access success rate after increasing the power level of all the cells. It must be mentioned that in this case study, at first, only 46% of the cells work under maximum power definition. We must note that after enhancing the power, overshoot maybe experienced in some cells, and this can cause degradation in other KPIs. The signal of such cells should be controlled by down-tilt, reducing the height of antennas and/or changing the azimuth.

- **Increase the Number of SDCCH**

Sometimes the lack of sufficient number of SDCCH is due to cells with bad performance. In that case, this condition has utmost effect on SDCCH congestion. As mentioned already, the SDCCH Congestion leads to low SDCCH Access Success rate.

Figure 16: Increasing the number of SDCCH for the particular cell

Figure 16 shows that by increasing the number of SDCCH for a particular cell with SDCCH

Congestion, the rate of SDCCH Access Success can be enhanced.

- **Replacing Mechanical tilt by Electrical tilt**

Mechanical tilt has negative effect on SDCCH access success rate. In figure 17, you can clearly see how this rate has been improved by replacing Mechanical tilts with Electrical tilts.

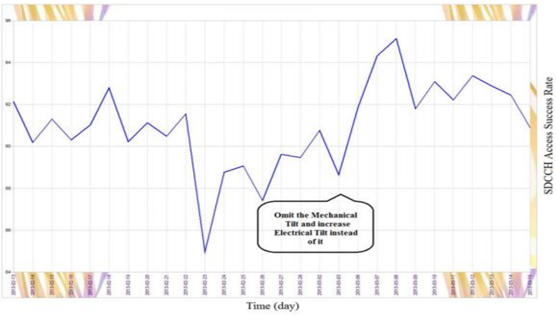

Figure 17: Effect of Mechanical tilts on SDCCH Access Success

- **Removing Hardware Failures**

Hardware problems such as faulty feeders, antennas, TRX, combiners, connectors, incorrectly connected RF cables, or anything related to hardware failure, will make it difficult to seize the SDCCH, and thus, the SDCCH Access Success rate decreases.

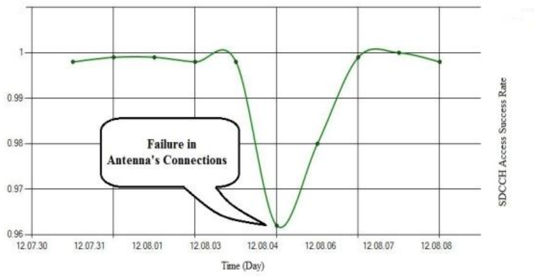

Figure 18: Failure in connectors of antenna

Figure 18 shows the decrease in SDCCH access rate due the failure in antenna connectors.

- **Removing the Faulty BTS Database**

If the data base of a specific site is loaded incorrectly, the performance of that site will be affected extremely. For instance, in a case of baseband hopping, there were more TCH frequencies added than it was required. As a result, a number of physical channels in Air-interface went into the unused mode. After pondering on data base and eliminating the redundant frequencies, the site performance improved and subsequently, the SDCCH Access Success rate increased. In figure 19, this betterment is shown.

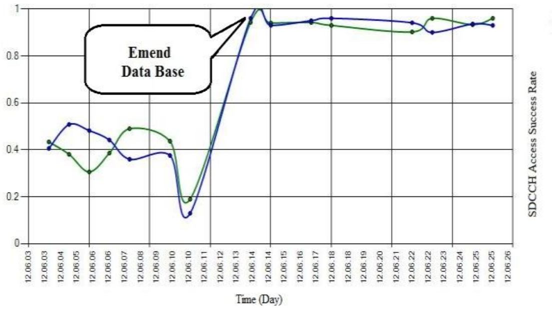

Figure 19: Modifying the Data Base failure

Obviously, this repairing had effect on other KPIs, such as SDCCH Congestion, SDCCH Drop, TCH Congestion, Call Setup and so on.

- **Modifying the Number of PDCH**

Sometimes the resources in the Abis link are not equally shared. For instance, when a specific cell with low TCH traffic is involved in TCH and SDCCH congestion, this congestion affects its SDCCH Access Success. By dedicating appropriate physical channels to the PDCCH and TCH, the degradation of SDCCH Access Success rate can be avoided.

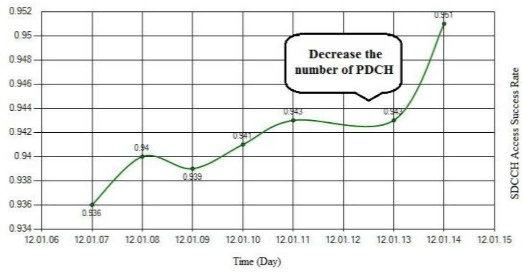

Figure 20: Influence of PDCH reduction in specific BTS

- **Avoiding the Congestion by Cell Load Sharing**

As mentioned earlier, one of the most important issues affecting the SDCCH Access Success is TCH or SDCCH congestion. By adding TRX to any cell with congestion, this issue can be solved. However, in cases where a specific cell is working with high configuration and there is no option for adding additional TRXs, setting the cell load sharing feature will solve the issue. As we can see in figure 21, after solving the congestion the SDCCH Access Success is ameliorated.

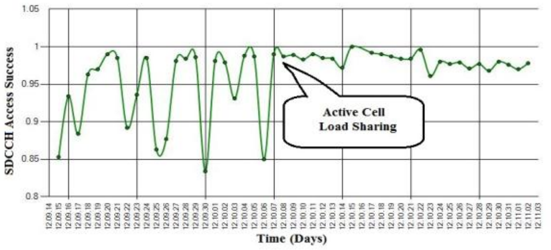

Figure 21: Using Cell Load Sharing

- **Migrating the MSC from Classical Switch to the Soft Switch**

It is rather interesting that, after transition from Classical-Switch to the Soft-Switch, tremendous SDCCH Access Success improvement has been observed.

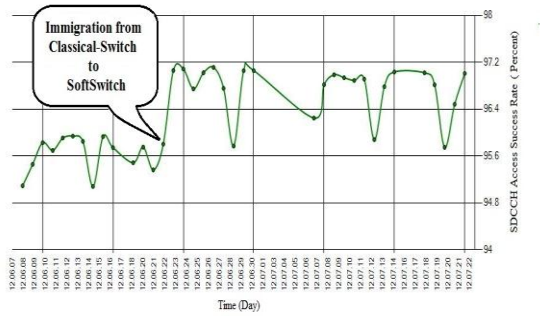

Figure 22: Changing the Switch

- **Setting Limitation for TA**

By exerting the limitation for TA the cell signal is controlled; by confining the signals the overshooting and low SS could be avoided. If the measured timing advance value for an access burst is equal or greater than MAXTA, then the connection set-up signaling is terminated by the system. If the measured and averaged timing advance value for an ongoing call is equal or greater than MAXTA, the call will be released. It must be considered that by terminating the connections, Call Drop will occur. To avoid this defect, TALIM shall be used. If the measured and averaged timing advance value is equal or greater than TALIM, the cell must be abandoned immediately, only if there is an existing neighboring cell which can take over the connection; otherwise, no actions shall be taken. In other words, MAXTA is “hard limit” whereas TALIM is “soft limit”. For a particular BSC which covers a dense city area, due to the density of sites, the MAXTA is set to 16 and TALIM is set to 13. The effects on SDCCH Access Success are shown in figure 23.

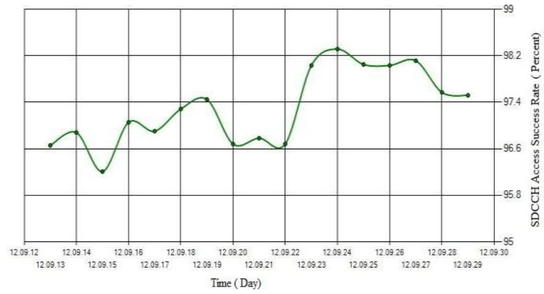

Figure 23: Setting MAXTA and TALIM

- **Frequency re-planning**

For coping with the interference in a network, it is better to re-plan the BCCH and TCH frequencies in every few months; the figure 24 is shown how to improve SDCCH Access Success by setting proper frequencies.

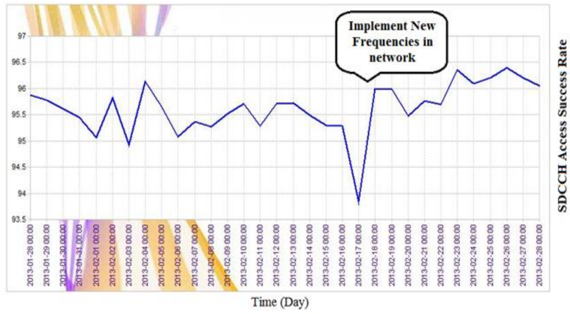

Figure 24: SDCCH Access Success Rate in BSC

In figure 24, the betterment of SDCCH Access is shown in a particular BSC.

- **Adding C2 for 1800 band in dual band sites**

In order to control the traffic distribution between cells in dual band sites, it would be beneficial to use the capability of Cell Reselection (C2) criteria. However, prior to using this criterion, the performance of each band should be considered, and C2 must be active in the band with better quality.

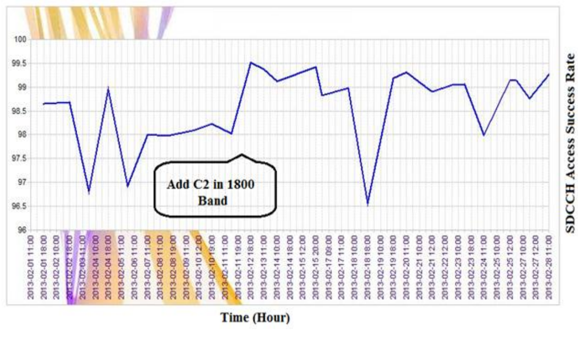

Figure 25: Better of SDCCH Access Success Rate after adding C2

- **Avoiding Network to send numerous SMSs**

In an experiment, it was noticed that, when high volume of SMS are sent through the network by the operator, the network in general and classical switch, did not endure this carrier and majority of the indicators were led into critical mode, whereby the SDCCH Access Success rate degraded.

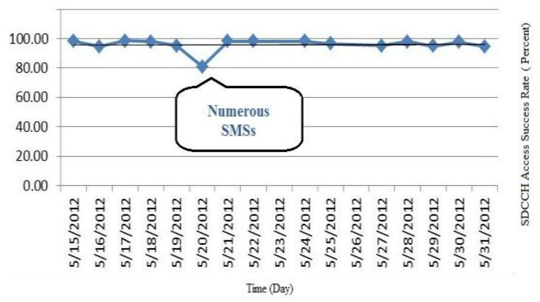

Figure 26: Effect of numerous SMS

In figure 26, this incident is shown; this survey was conducted for a specific BSC.

- **SDCCH Power Regulation Feature [3]**

By Software Switch (ON/OFF) for SDCCH regulation, the power regulation is allowed on SDCCH. It can be used for the areas with good coverage.

- **SDCCH Handover [3]**

SDCCH handover procedure is identical to TCH handover; the locating function prepares a ranking list and sends it to the handover function. This handover is achieved in two categories of intra-cell and inter-cell. Intra cell handover from one SDCCH into another SDCCH within the same cell; and inter-cell handover is between SDCCHs belonging to different cells within a BSC. The conditions of high signal strength and poor signal quality in terms of a large BER26 on air interface must be fulfilled in order to make an intra-cell handover instead of an inter-cell handover. In other words, SDCCH handover can be used in networks with good coverage.

- **Avoid using combined BCCH/SDCCH [6]**

Combined BCCH /SDCCH must be used only in BSCs which carrying very little traffic.

- **Scattering SDCCHs [6]**

By scattering one of SDCCHs on the BCCH carrier and others on hopping layer, the SDCCH Congestion will be reduced, resulting in a positive impact on SDCCH Access Success.

- **TX-Integer [3]**

For improving the SDCCH Establishment Success, one of the most related parameter is TX-Integer. The TX-Integer defines the number of timeslots in the interval between multiple channel requests sent by UE. This parameter mainly affects the execution efficiency of the immediate assignment (AGCH) procedure. When the success rate of call setup (immediate assignment) is low, the value of this parameter can be set to a higher value. By proper setting of TX-Integer value, the SDCCH access success is improved.

- **Avoiding Access Burst from another Co-Channel and Co-BSIC cell**

If in an area two cells broadcast the same BCCH with the same BSIC, interference enhances intensively; and this has a negative impact on SDCCH Access rate. Furthermore, an MS will not be able to distinguish between the real and the fake SDCCH; therefore, accessing to SDCCH will be degraded.

- **Using enable ordinary calls on FACCH**

Activating this parameter in cell level, will enable us to have ordinary calls on FACCH. FACCH call setup is only possible when SDCCH congestion occurs. Figure 27 shows that the SDCCH accessing is ameliorated after the activation of this feature.

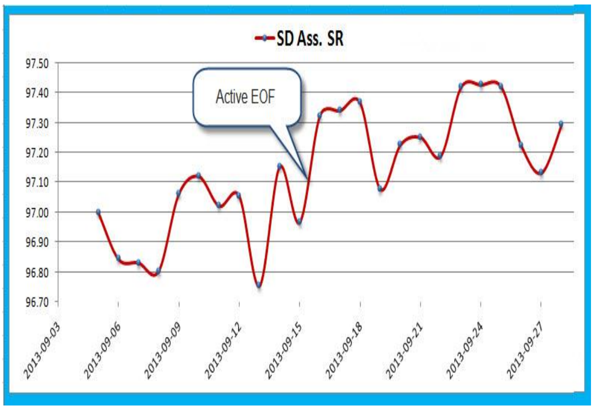

Figure 27: Effect of EOF feature

- **Changing MS Maximum TX Power**

This parameter changes the maximum Transceiver Power Level (TXPWR) in dBm. MS may use this when accessing on a Control Channel (CCH).

Figure 28: Influence of modifying MS Maximum TX Power

Figure 28 shows the improvement of SDCCH establishment after modifying this parameter from 33 to 36 on 1800 band and from 30 to 39 on the 900 band.

- **Modifying BTS Measure Average (BMA)**

This parameter defines the average number of SACCH multi-frames to be used in measurements performed in the BTS. The BTS calculates averages of all measurements performed by the BTS and the MS. The BTS is able to calculate the average on 2, 3, or 4 SACCH multi-frames. Value 1 denies averaging.

Figure 29: Effects of BTS software reload

- **Reloading BTS Software**

Sometimes the software of BTS should be reloaded; this action in Ericsson is called IDB[26]; and in Nokia is called re-commissioning.

After reloading the software, the BTS resets and works with correct data, which then improves the SDCCH Access, as illustrated in figure 30.

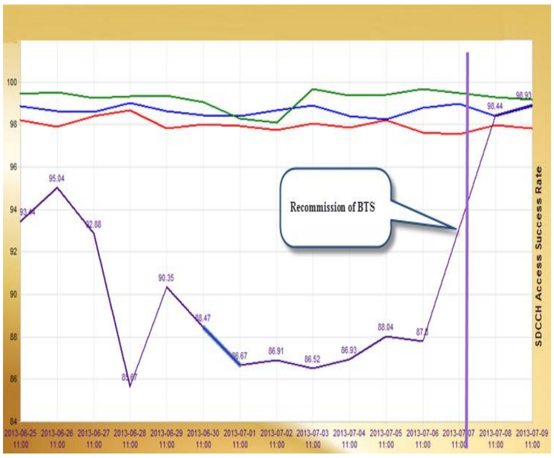

Figure 30: Effects of BTS software reload

- **Adding Cell Reselect Hysteresis parameter to the edge border cells**

This parameter changes the Received Signal Level (RXLEV) hysteresis, in dB, for required cell reselection over the location area border. It goes without saying, that, the location update is occurred in every handover between two BSCs. In this case the probability of SDCCH accessing is reduced. Furthermore, the SDCCH traffic and hence its congestion goes up, causing degradation of SDCCH access success rate. By adding CRH in cells edge border, the ping pong handover between two BSCs is decreased.

- **Modifying of Periodic Location Update**

As previous section SDCCH contributes the location update then the SDCCH Access Success is affected, this parameter defines the time-out value, which controls the location updating procedure, that is, when notifying the availability of the MS to the network. By setting proper time, the SDCCH Access Success is ameliorated, the following figures shows this

26 Installation Database

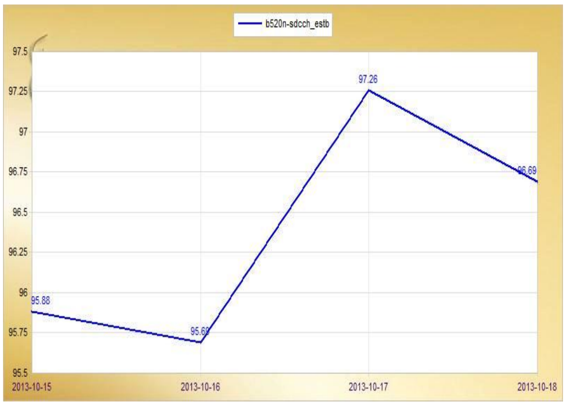

Figure 31: SDCCH Access Success Rate after modifying the time of Location Update

- **Solving the UNSOLICITED DATA LINK RE-ESTABLISHMENT Alarm**

This alarm occurs when the signaling link of TRX is unstable, in following figure the counts of alarm compare with SDCCH Access Rate in the Nokia network with 14 BSC in 4 days.

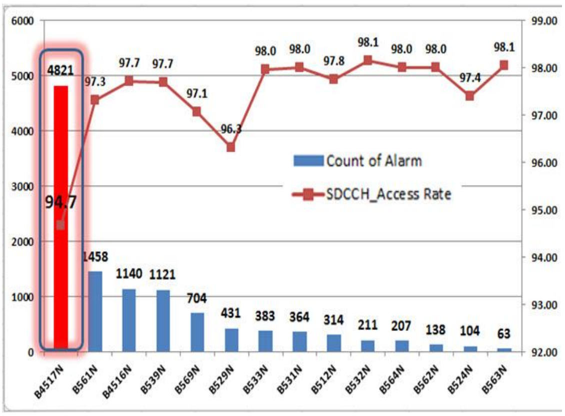

Figure 32: SDCCH Access Success Rate compare with Count of alarm

- **Removing Extra SDCCHs**

According ERLANG B SDCCH Dimensioning, when the SDCCH cannels defined more than the traffic on it, the SDCCH Success Access is so affected, the figure 33 shows that after removing extra SDCCH channels, the accessing to this logical channels is successful.

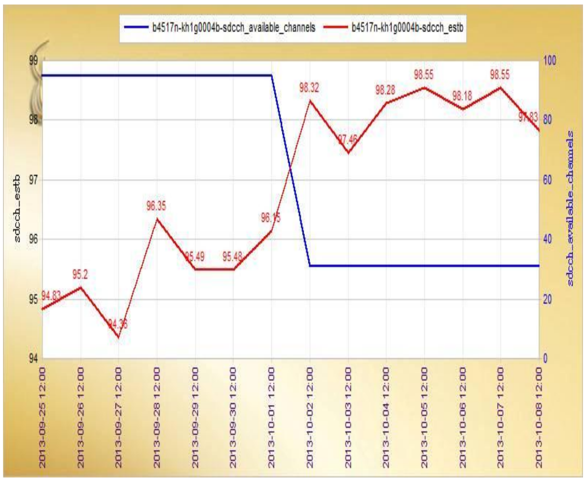

Figure 33: SDCCH Access Success Rate after removing the Extra channels

- **Moving SDCCHs to good Quality TRXs**

Sometimes the TRX that carries the SDCCH traffic is not in good conditions, and works with low SDCCH Access Success Rate, it is better to change the TRX that SDCCH is on it.

7. Conclusion

After pondering deeply, we can see some indicators in KPIs have both direct and indirect relationship with each other. If one indicator is enhanced, other parameters will improve accordingly. These interactions can be considered as clues, which will help us achieve certain approaches. It is obvious that sites with poor performance affect all the neighboring cells. Consequently, the neighboring cells must compensate this defect. Therefore, most of the cells in one BSC should work properly in all aspects and avoid faulty software and hardware, overshooting, TCH or SDCCH drops and congestion on TCH or SDCCH. Moreover, all cells must be planned well and be able to cover their areas with sufficient signal strength. The attempt of this paper was to demonstrate all aspects of each issue, which has never been considered before, and to present all practical solutions for solving problems related to SDCCH accessing. These schemes, not only have increased the SDCCH Access Success rate, but also, contributed to the improvements on the SDCCH Drop, SDCCH Mean Holding Time and SDCCH Establishment Success; and overall the network QoS is ameliorated. Moreover, most of the schemes mentioned for GSM can be simulated for any other existing cellular network as well as for the future generations to come.

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