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MEASUREMENT AND ANALYSIS THE QOS & KPIS OF CELLULAR NETWORK OPERATORS AT CAPITAL OF YEMEN SANA`A

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ABSTRACT

Key performance indicators (KPIs) and drive tests are used to evaluate the performance of an operational cellular communication network. These counters are converted into a more readable way. The objective of this paper, study KPIs and Quality of Service (QoS) of the performance of the cellular network in the city of Sana'a, the capital city of the Republic of Yemen. This paper discusses three subjects. In the first section Measurement and Analysis the parameters for circuit-switched Voice services and packet-switched data services which is one of the major KPI, which should be optimized to improve QoS, in the second section, Measurement and Analysis the Received Signal Level And Quality of cellular stations. In the third section Measurement and Analysis, the Called Passive Method. Hence, it can be concluded that it has been analytically proved that we can optimize an existing cellular network using different methodologies and fine parameter tuning to offer remarkable QoS to the end-users, despite its positive results. This research in the Republic of Yemen is considered to be, a rare research and it can be said from the first researches on this subject in the Republic of Yemen.

KEYWORDS: Measurement, Cellular Networks, Quality of Service, Key Performance Indicators, Speech Assessment, Voice and Data Service.

1. INTRODUCTION

The increase in subscribers pushes the telecom companies to increase the number of their services, and more importantly, this is the concern for the quality of service. Therefore, the companies monitor and measure the quality of their network service to achieve customer loyalty, which enhances and creates a competitive advantage among the telecom companies in the region. Technological progress in complex technical and other restrictions that most cellular network users are not interested in being all users of the network, from the user's point of view the most important thing is to ensure the performance of calls, hence the difficulty for telecommunications companies in setting up the quality of calls and the level of voice quality during calls and areas that are characterized Sound quality, therefore, the highest performance of the core technology does not concern the user of the network. We find that creating customer satisfaction is one of the main foundations of establishing the telecommunications industry and it applies to all areas of life while achieving profit motives. Unfortunately, it is still believed to this day that the quality of service is less than the standard level despite the known and widespread progress recorded in the telecommunications industry [1]. When we compare the number of studies that show the benefit of the quality of service to satisfy the users of cellular communication networks with the number of studies that show the effect of quality of service to satisfy users of telecommunications networks, we find that the number of first research is much greater than the number of research in the second [2-5]. Which makes the importance of research in the quality of service very important, there are several studies in this field compared to the number of studies in developing countries (various references from both countries), and it has been confirmed and not mentioned in the Republic of Yemen [6]. We want to note that the current political situation in which the country is going through (war) has led to the extreme difficulty in obtaining administrative facilities and the necessary licenses and data. Therefore, the study was limited samples of cells affiliated to SabaFon Telecommunication Company.

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2. BACKGROUND FOR INFORMATION ELEMENT

We would like to state that all acquaintance is taken from the reference [7]. All current cellular communication networks support the following services:

1- circuit-switched (CS) services.
2- packet-switched (PS) services.

Which are key indicators, through which both KPIs and QoS are evaluated for the cellular communication networks.

2.1 Circuit-Switched (CS) Voice Services

It supports the following:
1- *Call setup success rate (CSSR):* It is considered proof of the possibility of successful calls initiated by the MS.
2- *Call setup time (CST):* Which is the time it takes to complete the address information.
3- *Dropped call rate (DCR):* Rate of calls not completed successfully.
4- *Speech quality (PESQ):*The quality of the voice clarity (speech) for the user.
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2.2 Packet-Switched (PS) Data Services

It supports the following:
1- *Attach success rate (ASR):* Probability that a subscriber can attach to the network.
2- *Attach time setup (ATS):* Time duration taken to attach to the network.
3- *Packet data protocol (PDP) context activation success rate (CASR):* Probability that subscriber can activate a PDP context.
4- *PDP context service access success rate (SACR):*Probability that a subscriber access the service successfully.
5- *Service session success rate (SSSR):* Probability of initiating the service by the subscriber.
6- *FTP data throughput (FTP DL):* Average data rate that can be achieved.

2.3 The Most Critical Kay Performance Indicators and their descriptions

- *TCH drop rate:* this is one of the most critical KPIs in GSM networks since it is annoying to the customer as well as the operator. It is the percentage of lost connections to the total number of connections for a given cell in the active mode (on call). The value of this KPI ranges from 2% in the initial launching of the cell and it must be decreased to 0.5% in normal operating conditions.
- *Standalone dedicated control channel (SDCCH) drop rate:* It is the percentage of the lost SDCCH connection with the total SDCCH connection attempts. SDCCH is used during vital roles such as call setup and mobile registration.
- *TCH congestion and congestion perceived by subscribing:* There are two different approaches when dealing with TCH congestion. The TCH congestion perceived by the subscriber is more realistic since it is from user's point of view rather than the congestion observed by the network and it is given by TCH congestion.
- *SDCCH congestion:* SDCCH is used during call setup, mobile registration and SMS. The SDCCH congestion is the percentage of the time that all SDCCH resources are busy within a given cell. The accepted value is no more than 0.5.
- *Strongest Scanned ARFCN:* ARFCNs of the scanned channels sorted by decreasing signal strength.

3. CONFIGURATION OF MEASUREMENT AND RESULTS

3.1 Drive Test System

We carried out the radio survey it is to do a field survey of the cell in order to obtain a set of data related to the cell (parameters of the cell), which helps to analyze the coverage of the cell site. The drive test System showed in Figure 2- 3.

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Figure 1. A sample of one way to derive test route

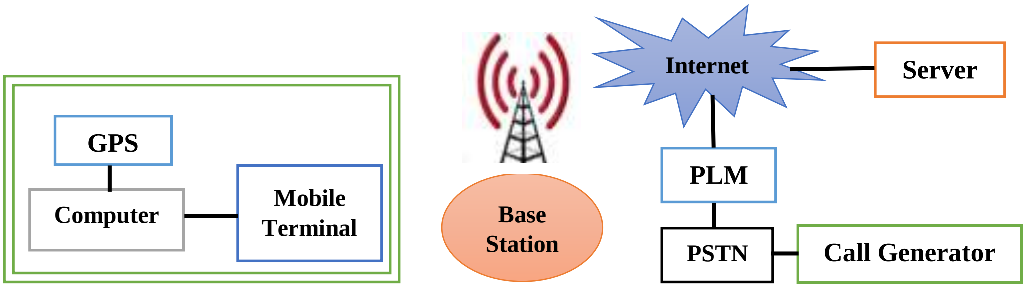

Figure 2. A diagram of the driving test system

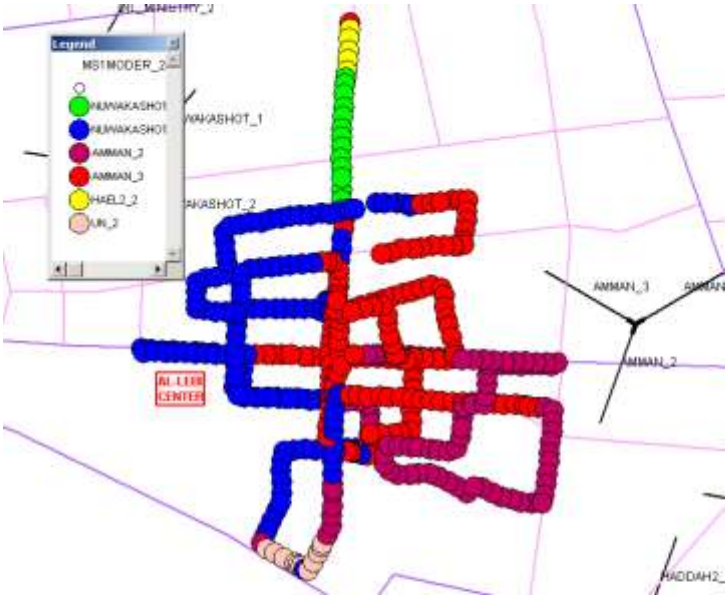

Figure 3. Drive test route in Sana'a city (Nuwakashot-1, Nuwakashot-2, Amman-2 , Amman-3, HAEL-2 and UN-2)

3.2 Circuit-Switched and PS Services

Since all mobile networks support both CS and PS services, we must evaluate the quality of QoS for each CS alone, and then evaluate the PS quality so that the evaluation process is separate, for accurate results.

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Table 1. Test results of CS and PS services.

Service	*KPI*	*Test Results*
CS (Voice)	CSSR	97.74 %
	CST	2.59 s
	DCR	1.16 %
	PESQ (avg.)	3.83
PS (Data)	ASR	100%
	AST	1.62 s
	CASR	100 %
	SACR	95 %
	SSR	95 %
	FTP DL	0.10 kbps

TCH congestion rate (TCHCR) The TCH rate is considered one of the important indicators of key performance, which must always be optimized in order to improve the quality of service.CSSR is usually affected for several reasons (radio interface is busy, SDCCH is not allocated to radio traffic in the incoming network, which has been increased naturally).

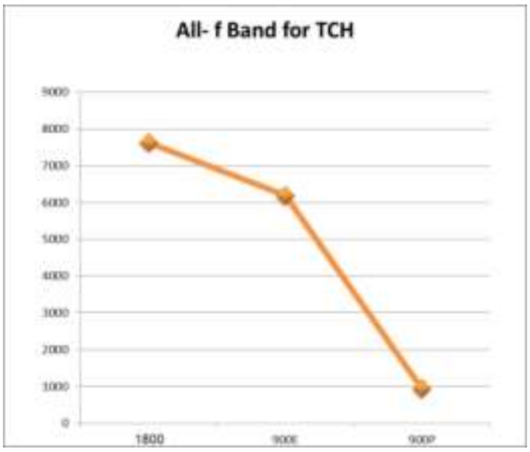

Figure 4. All frequency band for TCH

Since the transmission and basic receiving station (BTS) containing devices transmitter and receiver and in some cases gets the integration of these devices errors for several reasons, the most important (increase congestion coefficient TCH increase the number of subscribers to the network, increase traffic in a cell or an area) note that both CSSR KPIs and the worst percentage of cells is also considered one of the reasons that cause congestion.

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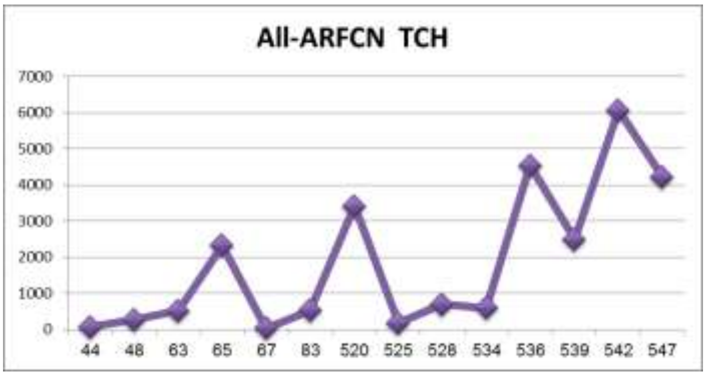

Figure 5. All-ARFCN TCH

When we reduce signal strength, in this case, ARFCNs are sorted by the scanned channels.

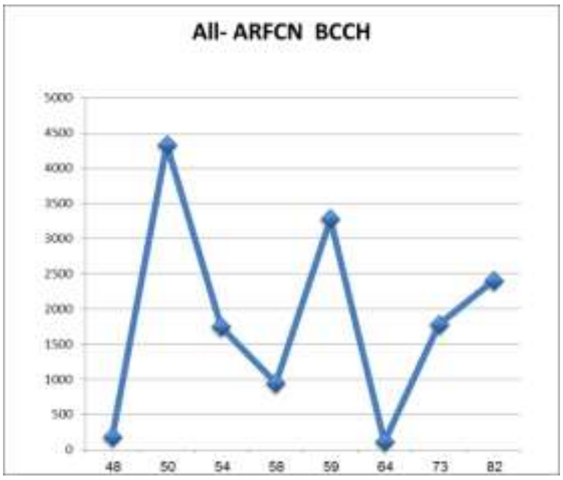

Figure 6. All-ARFCN BCCH

Table 2.ARFCN BCCH for GSM.

Mobile Network	ARFCN BCCH
GSM 850	128 ... 251
P-GSM 900	1 ... 124
E-GSM 900	0 ... 124 and 975 ... 1023
GSM 1800	512 ... 885
GSM 1900	512 ... 810

Among the procedures used to improve coverage, the HSR factor is a contributing factor to these procedures. It can also be used if you want to add the subsystem to the base station BSS resources, leading to improved coverage as well.

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When we reduce the signal strength, in this case, all scanned channels are sorted internally. Such as when the signal strength is reduced in the survey list of neighbors (0 - 846), all the channels converge so that all the neighbors come first, and then the other groups according to the strength of their reference.

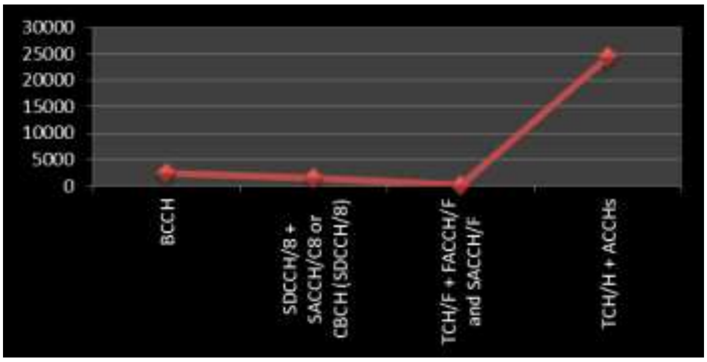

Figure 7. Distance due to the all channel types

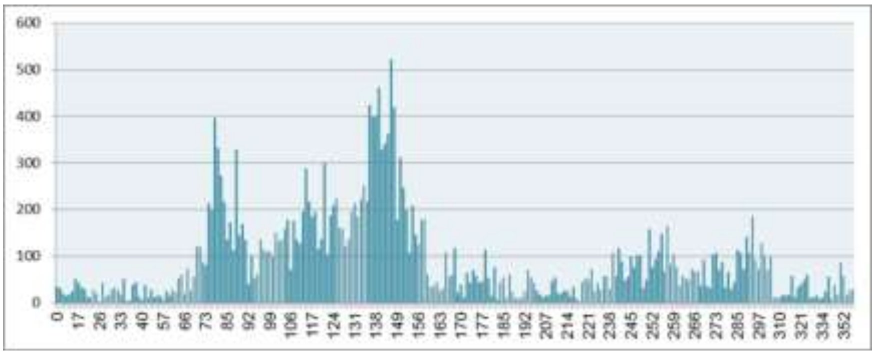

Figure 8. Distance due to the all heading

(0 -846) that 0 means the strongest channel of those currently scanned and so on, according to frequency bands from 450 MHz to 1900MHz.

3.3 Received Signal Level (RX-LEV) and the Received Signal Quality (RX-QUAL)

Both operands RX-LEV and RX-QUAL are considered the most important Gauges because they determine the quality of coverage in the cell through the measured level of the received signal.

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Figure 9. RX-LEV-Sub distribution in drive test in Nuwakashot-1, Nuwakashot-2, Amman-2 , Amman-3, HAEL-2 and UN-2.

For example, RX-LEV coefficient corresponds to the energy level of the rate during the call via the cellular phone system TEMS in the cell, and are measured every 470 milliseconds[7].

RX-LEV is the Received signal strength in units of dBm, GSM scale (minimum acceptable RXLEV is commonly set to –104 dBm for the cell. While RX-LEV value of –60 dBm is considered as excellent value) and RX-LEV-Subn is Received signal strength -Sub value expressed in dBm.

Table 2.Results of RX-LEV-Sub.

RX-LEV-Sub	No. of Samples
-65 to -23	154
-75 to -65	**201**
-80 to -75	55
-85 to -80	8

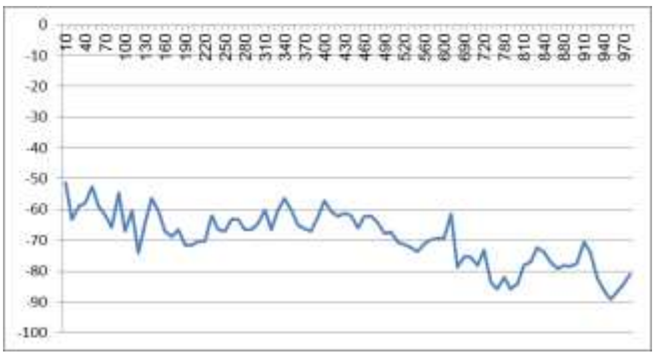

Figure 10. Distance due to the RX-LEV-Sub.

RX-QUAL: is a measure of the QoS, GSM scale (from 0 to 7, where 0 is the best quality and 7 are the worst).

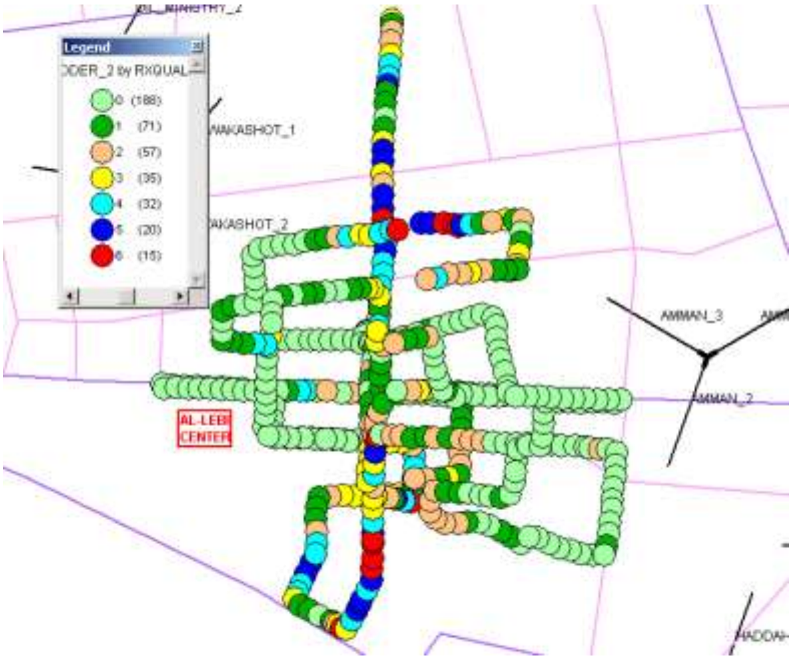

Figure 11. Rx-QUAL distribution in drive test in Nuwakashot-1, Nuwakashot-2, Amman-2, Amman-3, HAEL-2 and UN-2

Same as RX-LEV-Sub in Service (dBm) but valid only when the phone is in idle, dedicated, packet idle, or packet dedicated mode. Not valid when in limited service or no service mode.

Table 3. Results of Rx-QUAL

Rx-QUAL	No. of Samples
0	188
1	71
2	57
3	35
4	32
5	20
6	15

RX-QUAL Full- Received signal quality (Full value), calculated from the bit error rate

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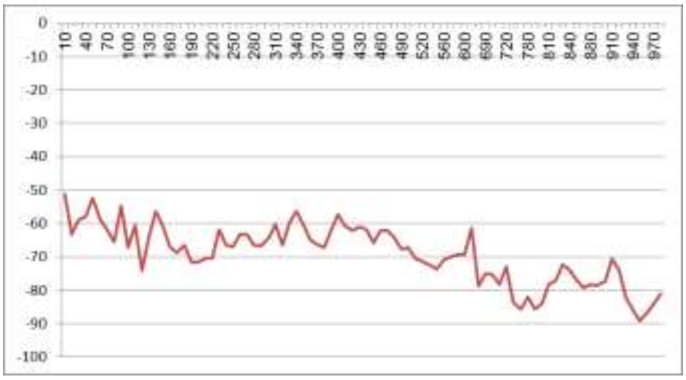

Figure 12. Distance due to the Rx-Qual

The number of samples with Rx-Lev less than -65 dB is almost negligible and Rx-Qual is good. In Street Nuwakashot-2 and Amman-2.And in Street (Nuwakashot-1, Nuwakashot-2, Amman-2, Amman-3, HAEL-2 and UN-2), Amman-3, HAEL-2 and UN-2) most of the samples within a period of -75 to 0 dBm with an average -85 dB. Note that the number of samples with Rx-Lev less than -75 dB is almost negligible and Rx-Qual is very good, the results shown in Figure 9-12 and Tables 2-3.

3.4 Called Passive Method

There are three operators (networks) in in the city of Sana'a, the capital city of the Republic of Yemen. Some of network GSM from Table 4 are then obtained as in Table 4, were directly measured the called passive method for each network are also presented.

Table 4. Mobile phone network systems and operators in Yemen

No	operators	Standard
1	SabaFon Company	GSM 900&1800
2	MTN Company	GSM 900&1800
3	Yemen Mobile Company	CDMA 1

We measured call procedures on the definite Base Transceiver Station (BTS) for a period of two days (Which we named in our search network operator k). The total number of successful calls (*SC*) and dropped calls (*DC*) by the network under study were recorded. When you want to know the quality of the call service In terms of the number of successful calls and the number of dropped calls or (failed calls), this is done by equations (1) and (2) [7-9]:

$$A = \frac{SC}{CA} \qquad (1)$$

Where:
A– Accessibility
CA - number of call attempts

$$R = \frac{SC}{NTC} \qquad (2)$$

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Where:
R-Retainability
NTC- number of normally terminated calls
At the same time of equations (1) and (2), we can obtain Dropped call rate (DCR**):**

$$\mathrm{DCR} = 1 - R \qquad (3)$$

So we can order to obtain DCR for cellular network as:

$$\mathrm{DCR} = \frac{\text{Number of TCH drops after assignment}}{\text{Total number of TCH assignments}} \qquad (4)$$

Table 5. Results of successful and dropped calls for network operator k

Time	Day-1		Day-2	
	SC	*DC*	*SC*	*DC*
6:00-7:00 AM	455	400	470	398
7:00-7:30 AM	420	400	418	401
7:30-8:00 AM	380	351	377	340
8:00-8:30 AM	400	360	410	371
8:30 -9:00 AM	384	352	391	349
9:00 -9:30 AM	390	349	399	370
9:30 -10:00 AM	387	340	392	343
10:00-10:30 AM	400	384	410	369
10:30-11:00 AM	387	352	392	376
11:00-11:30 AM	391	362	378	340
11:00-12:00 AM	411	367	406	387
1:00-2:00 PM	400	390	407	388
10:00-10:30 PM	450	150	490	120
11:00-12:00 PM	488	135	492	119

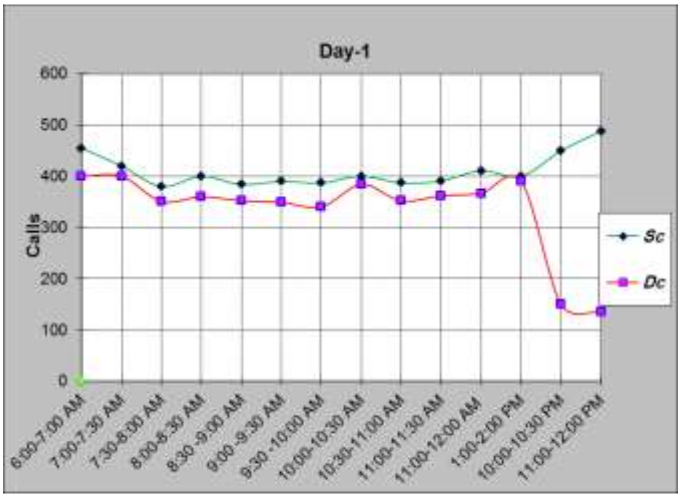

Figure 13. The total number of successful calls (SC) and dropped calls (DC) in day-1fornetwork operator k.

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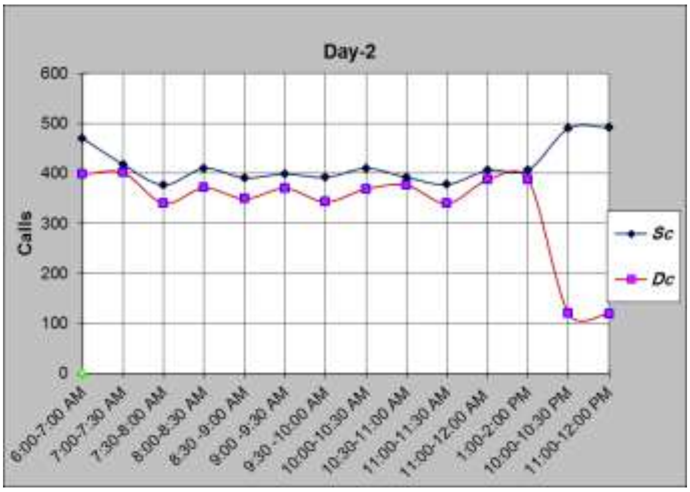

Figure 14. The total number of successful calls (SC) and dropped calls (DC) in day-2 for network operator k

The simulated data exposes the authentic performance of the network under study, on the assumption that all enabling conditions and infrastructures are in place, the number of successful calls is a little bit higher than the number of dropped calls, and so network operator k is bad according to the results shown in Table 5 and Figure 13-14.

4. CONCLUSION

This paper describes a study KPIs and QoS of the performance the cellular network in the city of Sana'a, the capital city of the Republic of Yemen, measurement and Analysis of the parameters for circuit-switched Voice services and packet-switched data services from Drive test results of circuit switched and packet switched services are a very good quality of service, which is one of the major KPI, which should be optimized to improve QoS. The received signal level and quality in cellular stations it was between good and very good and by measuring and analyzing the negative calling method, we find that the simulation data results, the network operator k is bad according to the results shown. Periodic measurements should also be made due to the changing architecture in the area.

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BIOGRAPHIE

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