Evaluation and optimisation of GSM network in Jenien City, Palestine

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Abstract: This paper presents a case study about the evaluation and optimisation of GSM network in Jenien City, Palestine. Two approaches are used to evaluate the network performance, namely: key performance indicators (KPIs) and drive test. The initial evaluation of the network showed that about 0.76% of the initiated connections are dropped. In addition, about 7.76% of the collected samples from the drive test lie in level 4 which is the worst level in terms of signal quality and signal strength. Moreover, only 65.5% of the collected samples lie in level 1 which is the best level in terms of signal quality and strength. A new traffic channel (TCH) and broadcast control channel (BCCH) frequency plans are proposed to decrease TCH drop rate, reduce interference level and boost signal quality. The proposed plans are implemented into the network. Two kinds of optimisation procedures are adopted. The first one is manual optimisation while the second one is by using specific optimisation tools. According to the comparative study, we carried-out between the performance of the network before and after optimisation, the average TCH drop rate is reduced from 0.76% to 0.62%. In addition, the percentage of samples in level 1 is increased from 65.5% to 76.8% while the percentage of samples in level 4 is decreased from 7.76% to 5.16%.

Keywords: global system for mobile; GSM; mobile network evaluation; mobile network optimisation; drive test; key performance indicators; KPIs; TCH drop rate; handover success rate; signal quality; signal level; Palestine.

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1 Introduction

Among the existing cellular networks, global system for mobile (GSM) communications is the most popular cellular communication system all around the world (Rappaport, 2001). This system was developed over time to include data communications by packet data transport via general packet radio services (GPRS) and enhanced data rates for GSM evolution (EDGE). Further improvements were made when the 3GPP developed third generation (3G) UMTS standard followed by fourth generation (4G) LTE advanced standard (Dahlman et al., 2011).

In recent years, a great deal of attention has been paid to the planning, evaluation and optimisation of mobile cellular networks (Mishra, 2004, 2007). There are several research papers in the literature that addressed the evaluation and optimisation of operational GSM networks. Thus, Haider et al. (2009) used the so-called key performance indicators (KPIs) to evaluate the performance of an operational GSM network. The network performance evaluation is based on four major KPIs, i.e., call setup success rate, call drop rate, handover success rate and traffic congestion. Every KPI is explored and improvement methodologies are suggested. However, these improvement methodologies were not implemented in the network. In Bouamalf et al. (2009), the authors evaluate the handled traffic and network utilisation of an operative GSM network during eight months. They developed a regression-based forecasting model for the traffic. The performance of GSM and GPRS operational network is presented in Kyriazakos et al. (2002) with a review of the most common KPIs that are used to evaluate the performance of GSM and GPRS networks. The relationships between these KPIs are introduced and thresholds for some KPIs are suggested so that the GSM operators should not exceed them. Jia et al. (2010) addressed the optimisation of GSM network, data sorting and analysing, implementing the optimisation and system fine tuning. Network dimensioning such as BSC, MSC and other related parameters are addressed and the top ten wireless parameters are listed which are the most important from the authors' point view. In Popoola et al. (2009), the KPIs for quality of service (QoS) evaluation in GSM network are identified. Four assessment parameters (network accessibility, service retainability, connection quality, and network coverage) for evaluating the QoS were applied on four GSM networks in Nigeria. The results of that study showed that the QoS of GSM networks in Nigeria is unreliable and the network accessibility and retainability are unsatisfactory. The study in Shoewu and Edeko (2011) aimed at presenting the QoS of network optimisation and evaluation of KPIs provided by GSM operators in terms of the ability to establish and maintain call connections, call retention, handover, inter and intra network call set-up. Gao et al. (2009) have proposed a measurable indicator of quality of experience (QoE) in EDGE networks, called busy hour throughput per user, which can be employed to direct practical network design and optimisation. In Selmi and Tabbane (2004), a semi-automatic tool is developed to perform the network optimisation by tuning the parameters of a live GSM network. The authors select the most common KPIs to evaluate the QoS and they assign thresholds for these KPIs. The developed tool is then used to suggest some recommendations that can be applied to the cell so as to enhance its performance. Kollar (2008) addressed the evaluation of the call set up success rate as one of the most important KPI in GSM system. They suggested calculating this KPI as the ratio of the assigned traffic channels (TCHs) to the channel requests.

From the literature survey above, some authors have suggested several approaches to improve the available KPIs. However, most of these approaches were not implemented and evaluated for a live GSM network. Other authors have used the drive tests to evaluate the performance of active GSM networks in terms of QoS. Nevertheless, to the best of our knowledge, there are no comprehensive research works that combine both the KPIs and the drive tests to evaluate and optimise the performance of operational GSM mobile networks. In this paper, a comprehensive research study is carried-out on the performance evaluation and optimisation of Jawwal[1] GSM mobile network in Palestine where Jenien City is selected as a case study. Our contribution is twofold: Firstly, both the KPIs and the drive tests are used to evaluate and optimise the performance of the GSM network in Jenien City. In addition, operation and support subsystem (OSS) optimisation tools are used in the final optimisation process. Secondly, a comprehensive comparative study is carried-out between the performance of the GSM network before and after the optimisation.

Figure 1 illustrates the various steps carried-out in this research. Starting from the operational Jawwal GSM network, an evaluation step is performed by using the data from network audit, KPIs and drive tests. After the evaluation step, an optimisation step is performed followed by implementation. The optimisation process is cyclic till the best performance for the network is reached. At that point a comparative study is carried-out between the performance of the GSM network before and after introducing the new implementation. This research is conducted from August 2010 till October 2011.

The remainder of the paper is organised as follows. In Section 2, the network audit of Jawwal GSM network in Jenien City is introduced. Section 3 deals with data collection interms of KPIs. In Section 4, the drive test data is listed and analysed. The optimisation work that is conducted manually or by using OSS tools is presented in Section 5. The comparative study for the performance of GSM network in Jenien City before and after optimisation is introduced in Section 6. Finally, the conclusion remarks are presented in Section 7.

2 GSM network audit in Jenien City

2.1 Basic information about the network

The selection of Jenien City[2] to perform this research is due to the high TCH drop rate and poor QoS. Table 1 shows the basic information about Jawwal GSM network in Jenien City by August 2010. This information includes active sites and cells, serving base station controller (BSC), serving Mobile Switching Centre (MSC), broadcast control channel (BCCH) and TCH frequencies and total number of transmitter-receiver units (TRUs).

Figure 2 is a map from PLANET software that illustrates all active and planned sites with cell directions in Jenien City. Note that the active sites are mentioned earlier in Table 1, whereas the planned sites are JENI23, JENI24, JENI25, JENI26, JENI27 and JENI29.

2.2 Frequency reuse plan

Although there are 124 channels in the GSM900 band, Jawwal GSM network in Palestine has only been allocated 24 channels. These channels are divided into traffic and control channels. More particularly, the available 24 channels are divided into 16 TCHs and 8 BCCHs. The TCH and BCCH frequency reuse plans are shown in Figures 3 and 4, respectively. The absolute radio frequency channel number (ARFCN) of the BCCH channels is from 117 to 124 whereas that of the TCH channels is from 101 to 116. The frequency reuse of 8 BCCHs in 57 GSM cells of Jenien City results in high level of interference on the BCCH, which is more critical than the interference on the TCH channels. This results in poor QoS and high drop rate for these cells. To avoid this problem, one can increase the number of BCCH channels. However, due to the limited number of channels available to Jawwal GSM network (24 channels), it comes at the cost of reducing the number of TCHs.

Figure 1 The various steps carried-out in this research which is conducted from August 2010 till October 2011 (see online version for colours)

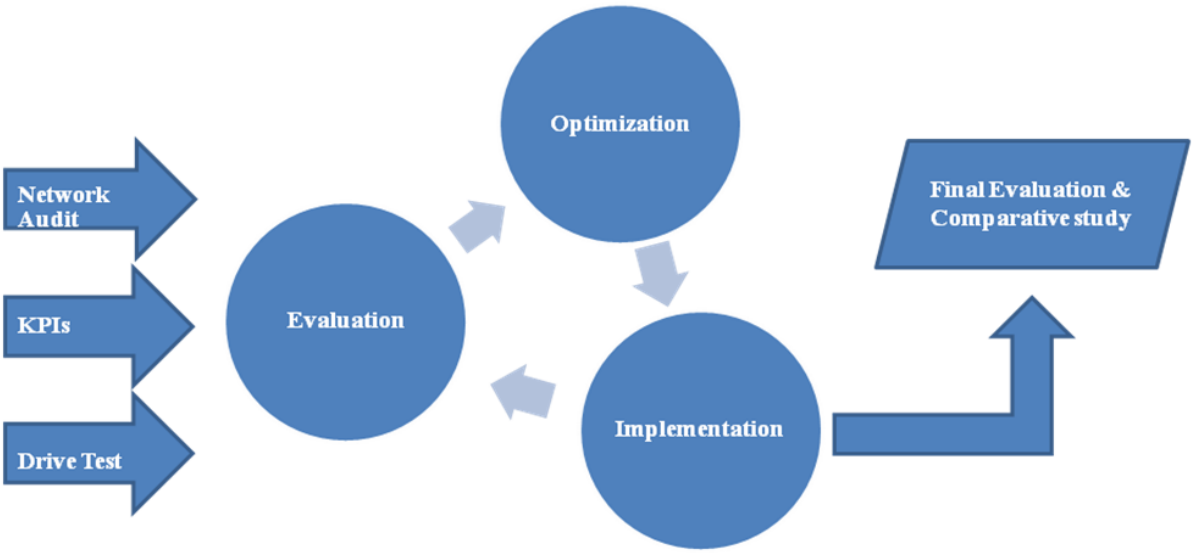
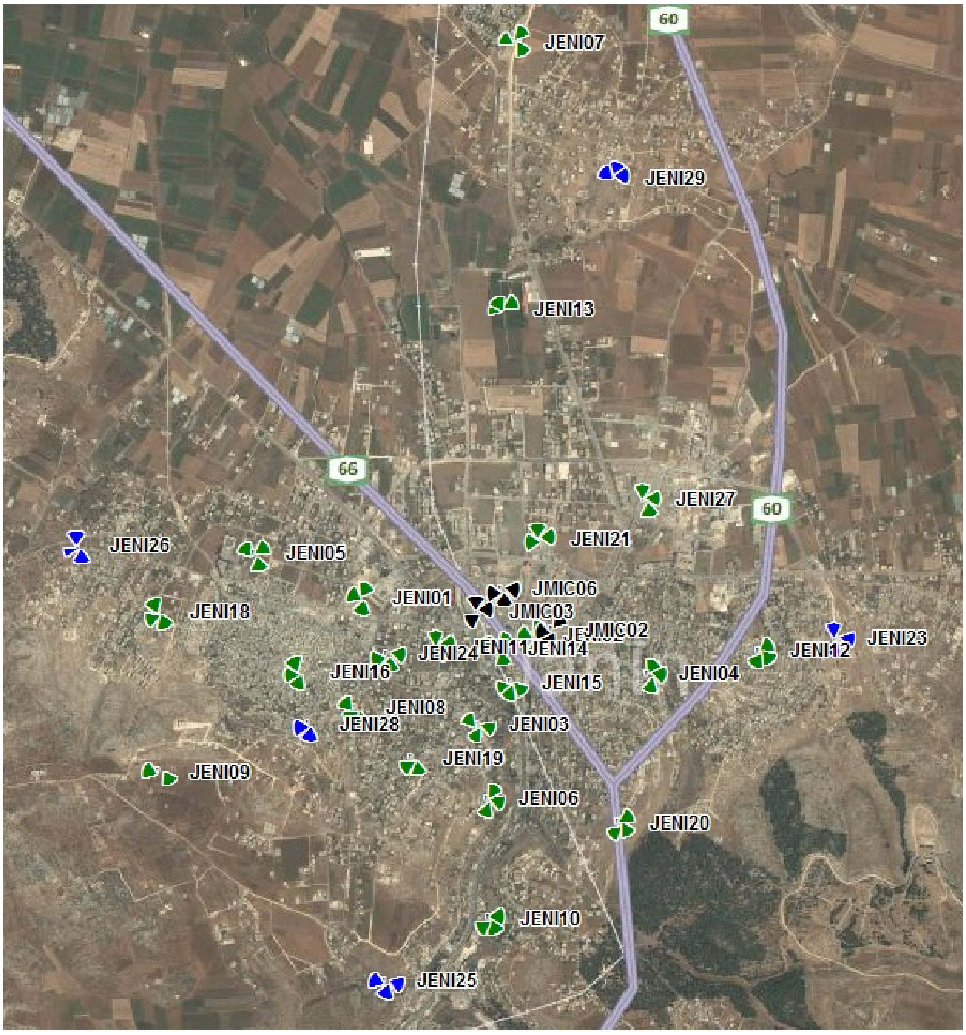


Table 1 Basic information about Jawwal GSM network in Jenien City

Active sites in Jenien City	JENI01, JENI02, JENI03, JENI04, JENI05, JENI06, JENI07, JENI08, JENI09, JENI10, JENI11, JENI12, JENI13, JENI14, JENI15, JENI16, JENI17, JENI18, JENI19, JENI21, WMIC03.
Total number of sites	21 Sites
Total number of cells	57 Cells
Total number of BCCHs	8 Absolute radio frequency channel number (ARFCN)
Total number of TCHs	16 ARFCN
Total number of TRUs	237 TRUs
Serving BSC	BSC10
Serving MSC	MSC05

Figure 2 PLANET software map that shows all active and planned sites of Jawwal GSM network in Jenien City (see online version for colours)



Note: PLANET is a professional software tool used as GSM sites database and for coverage prediction.

Source: See the following link: www.mentum.com/planet

Figure 3 The BCCH frequency reuse plan of Jawwal GSM cells in Jenien City by August 2010 (see online version for colours)

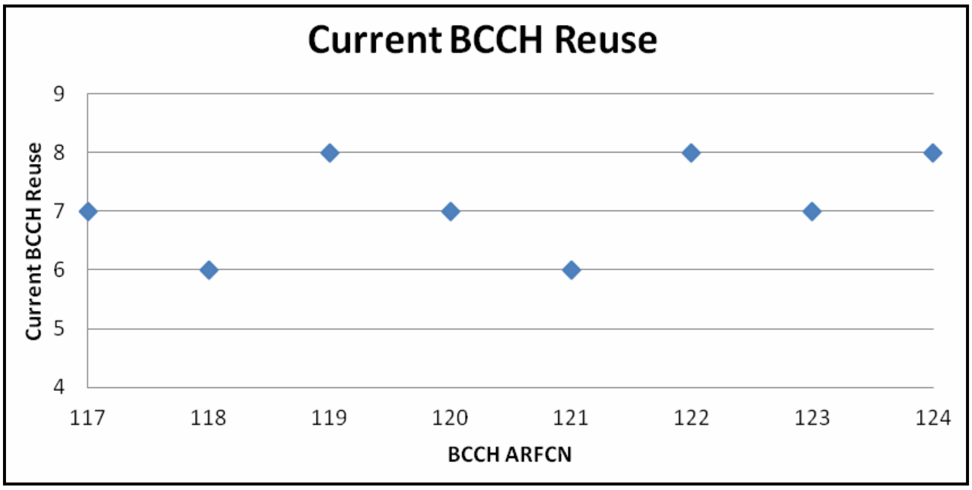
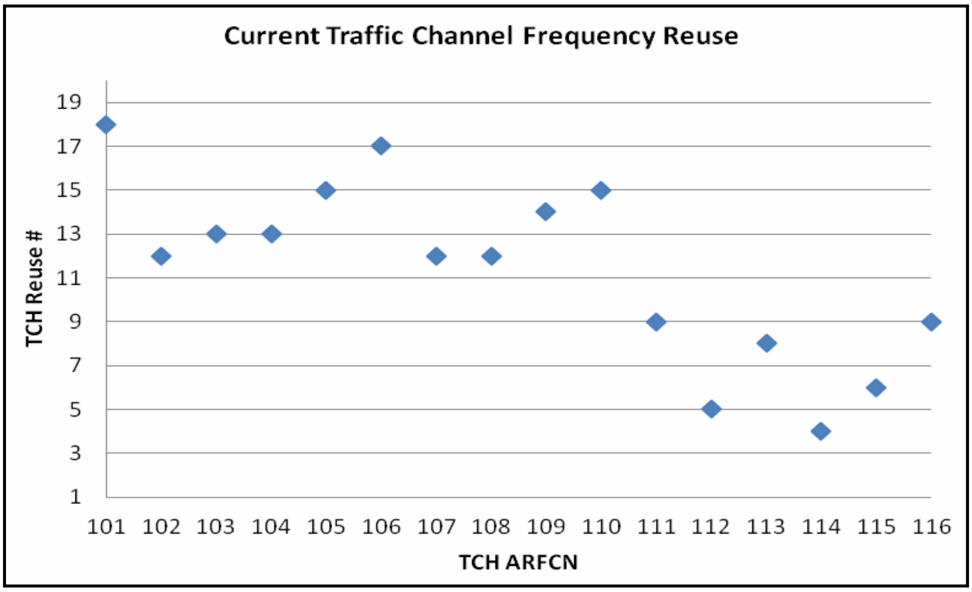


Figure 4 The TCH frequency reuse plan of Jawwal GSM cells in Jenien City by August 2010 (see online version for colours)



According to Figure 4, some TCH channels are reused more than 15 times whereas other TCH channels are reused less than ten times. This results in non-uniform distribution of reusing TCH channels. A more tight frequency plan and balance between the TCH and BCCH channels will be proposed later in Section 5.

2.3 Neighbour relation plan

Neighbour relations are essential when considering mobile station (MS) handover from one cell to another to maintain good QoS. The neighbour relation plan is constructed depending on the geographical locations of the cells and on suggested mobility profile. It is recommended to have neighbour relations of each cell between 6 to 15 cells. On the one hand, fewer neighbour relations mean that there will be dropped calls because of the missing neighbour relations. On the other hand, too much neighbours results in additional load on the BSC and MS at the handover attempt. According to the neighbour relation plan that is defined for each cell in Jenien City, the average number of neighbours is about 18 neighbours per cell. In addition, about 59.6% of the cells have more than 15 neighbour relations.

3 Key performance indicators

KPIs are used to evaluate the performance of an operational GSM network. These KPIs come in form of counters from the OSS of GSM network. These counters are then converted into a more readable way. The most common KPIs are listed below:

1. 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 for the cell and it must be decreased to 0.5% in normal operating conditions.
2. Standalone dedicated control channel (SDCCH) drop rate: it is the percentage of the lost SDCCH connections to the total SDCCH connection attempts. SDCCH is used during vital roles such as call setup and mobile registration.
3. TCH congestion and congestion perceived by subscriber: there are two different approaches when dealing with TCH congestion. The TCH congestion perceived by 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.
4. TCH assignment success rate: it is a measure of the successful TCH assignments to the total attempts. It is recommended to keep this value as close to 100% (typical value is 99.7%).
5. Handover success rate: it is the percentage of successful handovers to the total number of handover attempts.
6. 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.

The KPIs provide comprehensive data about the cell behaviour in both uplink and down link. These data can be obtained without the need for extra measurements. Nevertheless, a specialised knowledge is needed to retrieve these data from the OSS of the GSM network. In this research, the KPIs are obtained and analysed in two phases. The first phase was during the month of November 2010 while the second phase was during the month of October 2011. Between these two phases, an optimisation and implementation steps are carried-out. The results of these two phases are presented in Section 6.

4 Drive test analysis

As mentioned earlier, there are two approaches to evaluate the performance of a live GSM network, namely KPIs and drive tests. On the one hand, KPIs give us detailed statistics for many events in GSM cells. On the other hand, drive tests show the realistic experience of the customer. Customer's point of view is more important since it reflects the real life scenarios. The drive test system consists of the following:

1. Software for data collection, such as TEMS[3] investigation, installed on a laptop.
2. One or more MS, depends on type of the drive test to be made. Commonly two MSs are needed one is used in connected mode (dedicated mode) to measure the QoS, handover and other serving cell parameters during the call. The other MS is used as scanner (idle mode) to scan all the available GSM900 band frequencies. The scanner MS is useful to detect the interfering cells on the serving cell.
3. A global positioning system (GPS) receiver to place the collected samples on their corresponding coordinates on a digital map.

TEMS investigation data collection Version 8.1 is used for drive testing of GSM network all over Jenien City. This drive test was performed in August 2010. TEMS investigation route analysis and Actix[4] analyser are the post processing tools used for analysing these collected drive test log files. The advantages of the drive test are: Firstly, drive test is a powerful tool for the radio frequency (RF) analysis and problem solving. Secondly, scanner tool used in drive test is a very good tool for detecting interfering signals. Finally, the drive test gives the exact geographical location for each sample through the connected GPS receiver. There are many parameters that are gathered by the drive test. The most important parameters are the received signal level (RXLEV) and the received signal quality (RXQUAL). RXLEV is the received signal power in units of dBm. The minimum acceptable RXLEV is commonly set to –104 dBm for the cell. While RXLEV value of –60 dBm is considered as excellent value. For a customer to be able to access the GSM network, it is strongly recommended that there will be a sufficient coverage with acceptable quality. RXQUAL is a measure of the QoS and it is given by GSM scale from 0 to 7, where 0 is the best quality and 7 is the worst. TEMS uses RXQUAL to identify the quality of a voice call or data session during the dedicated mode. RXQUAL is used to estimate the quality of GSM network service measured interms of Bit Error Rate (BER) before channel decoding. Table 2 shows how the RXQUAL is mapped to the BER percentage.

Table 2 RXQUAL with corresponding BER values

RXQUAL	*BER percentage*
0	<0.2%
1	0.2% to 0.4%
2	0.4% to 0.8%
3	0.8% to 1.6%
4	1.6% to 3.2%
5	3.2% to 6.4%
6	6.4% to 12.8%
7	>12.8%

In August 2010, a drive test was carried-out in the streets of Jenien City. The distributions of the collected signal samples of RXLEV and RXQUAL are shown in Figures 5 and 6, respectively.

Figure 5 RXLEV distribution of the collected samples from the drive test in August 2010 (see online version for colours)

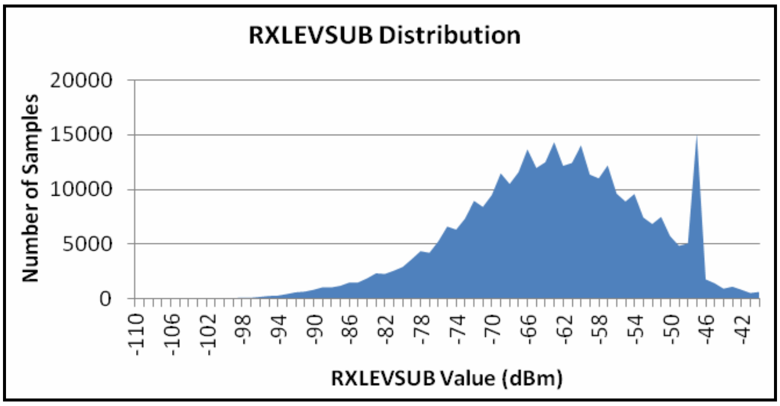
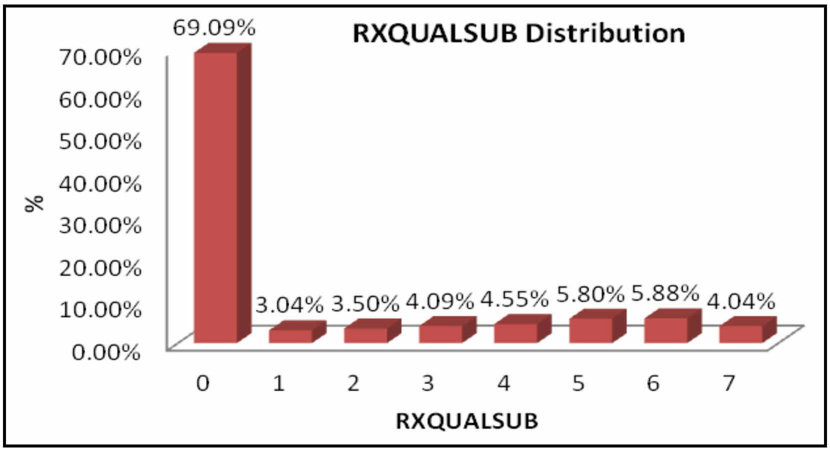


Figure 6 RXQUAL distribution of the collected samples from the drive test in August 2010 (see online version for colours)



According to Figure 5, most of the samples are within the interval from –42 to –85 dBm with average of –63.39 dBm and with standard deviation of 10.43 dBm. Note that the number of samples with RXLEV less than –85 dBm are negligible. Thus, the signal level in Jenien City is very good. A sharp spike around the value of –47 dBm comes from the fact that the drive test car stuck in traffic jam close to the RF site in the city centre such that many samples are taken with very good RXLEV. According to Figure 6, about 69% of the samples have excellent quality corresponding to RXQUAL value of 0. In addition, about 10% of the samples have poor quality corresponding to RXQUAL values of 6 and 7. To analyse the data from drive test, four coverage classes are defined interms of RXLEV and RXQUAL according to Table 3.

Table 3 Coverage levels legend in terms of RXLEV and RXQUAL

Coverage class	*Condition*
Level 1	RXLEV> = –70 and RXQUAL< = 2
Level 2	(RXLEV> = –85 and RXQUAL< = 4) and (RXLEV< –70 or RXQUAL>2)
Level 3	(RXLEV> = –100 and RXQUAL< = 6) and (RXLEV< –85 or RXQUAL>4)
Level 4	RXLEV< –100 or RXQUAL>6

Thus, level 1 is the best level since it guarantees the best of both RXLEV and RXQUAL. Level 2 provides the users with good RXLEV and good RXQUAL. Level 3 provides the user with acceptable RXLEV and RXQUAL. However, level 4 is the worst level since it combines poor RXLEV with poor RXQUAL. Table 4 shows the percentage distribution of each coverage class as obtained from the data collected during the drive test. According to Table 4, about 7.76% of the samples lie in level 4. Users in level 4 suffer from poor RF conditions that result in blocked calls, dropped calls, handover failures. The ultimate goal of this research is to reduce the percentage of samples in level 4 and to increase the percentage of samples in level 1.

Figures 7 and 8 show, respectively, the drive test maps of RXLEV and RXQUAL in Mrah area of Jenien City. This is important since it shows the geographical location for each sample. By inspecting drive tests of each area in Jenien City and the reasons for poor performance, it is concluded that the co-channel interference is the major reason for poor performance at almost all areas of Jenien City. Indeed, interference is a direct result of the poor frequency reuse plan that was adopted in Jawwal GSM network in Jenien City. Methodologies that will enhance the performance, improve quality and coverage, of the network are explained in the next section.

5 Optimisation of Jawwal GSM Network in Jenien City

The optimisation process consists of two stages which are the manual optimisation process and the automatic optimisation process using the OSS optimisation tools. The manual optimisation process starts with capacity analysis and neighbour relation plan. It yields two outcomes which are new frequency plan for both BCCH and TCH frequencies, and new neighbour relation plan. The outputs of the manual optimisation process are then fed to the OSS optimisation tools. The main output of the second stage is a frequency plan for BCCH and TCH channels with reduced interference. An enhanced neighbour relation plan with better handover performance is the other outcome of this stage.

5.1 Manual optimisation process

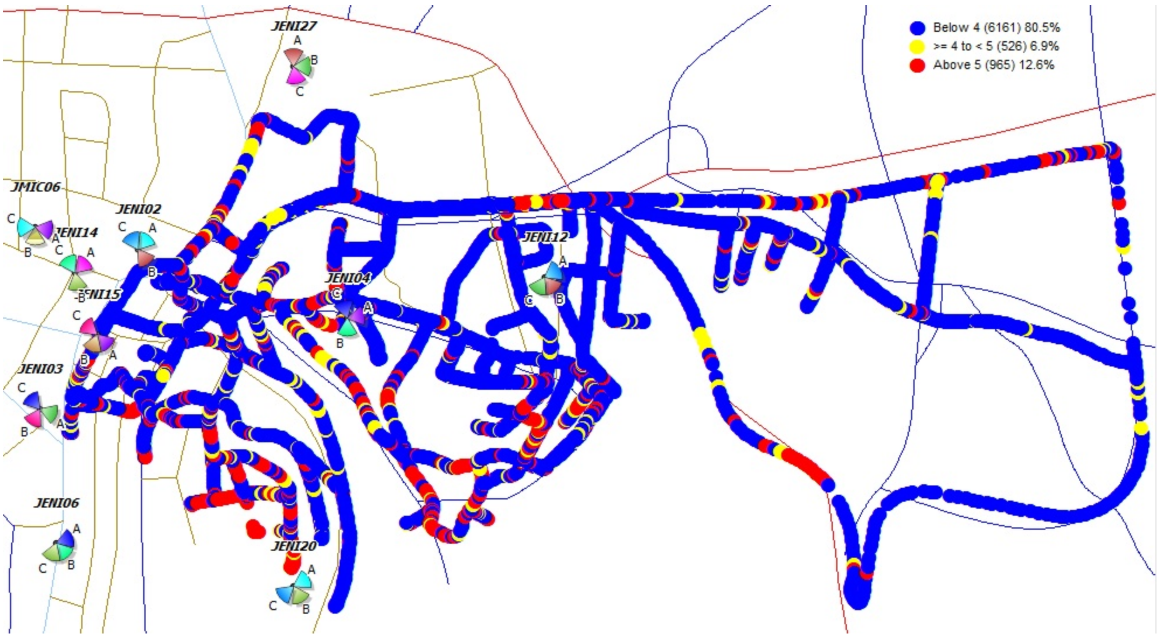
The manual optimisation step consists of two parts. The first one is capacity and interference analysis while the second one is neighbour relation plan.

Table 4 Percentages of coverage classes of Jawwal GSM network in Jenien City by August 2010

RXLEV/ RXQUAL	*RXQUAL≤ 2*	*2<RXQUAL≤ 4*	*4<RXQUAL≤ 6*	*RXQUAL> 6*	*Coverage class*	*Total %*
RXLEV≥ −70	65.46	6.97	7.56	4.99	Level 1	65.5
−70 ≥ RXLEV≥ −85	6.54	2.16	2.71	2.28	Level 2	15.7
−85≥ RXLEV≥ −100	0.28	0.25	0.3	0.45	Level 3	11.1
RXLEV≤ −100	0.02	0	0	0.02	Level 4	7.76

Figure 7 Drive test map for RXLEV in Mrah area of Jenien City by August 2010 (see online version for colours)

Figure 8 Drive test map for RXQUAL in Mrah area of Jenien City by August 2010 (see online version for colours)



The capacity analysis is a study in which the peak carried traffic is determined for each cell. Then, the exact number of needed TCHs is employed to handle that peak traffic for each cell. This will result in different frequency distributions between the BCCH and TCH frequencies.

To this end, let us start by defining the term ‘traffic intensity’ which is a measure of the channel utilisation or it is the average channel occupancy measured in units of Erlangs (Rappaport, 2001).

The traffic intensity offered by each user (A_u) is given by

$$A_u = \lambda H \qquad (1)$$

where λ is the average number of call requests per unit time and H is the average duration of a call. For a mobile system with capacity of U users, the total offered traffic intensity (A) is defined as

$$A = UA_u \qquad (2)$$

The grade of service (GoS) of a mobile system is a measure of the ability of a user to access the system during the busiest hour which is specified as the probability of a call being blocked. This blocking probability is given by the following Erlang B formula (Rappaport, 2001):

$$GoS = \Pr[Blocking] = \frac{A^C / C!}{\sum_{k=0}^{C} A^k / k!} \qquad (3)$$

where C is the total number of TCHs in a cell and A is the total traffic intensity. The above formula is usually tabulated for typical values of GoS, C and A (Mishra, 2007). Suppose that there is a cell with 2 TRUs, the rule of thumb for assigning control channels is to assign control channels equal to the number of TRUs. In this case, two control channels are needed. Thus, we have 2 TRU * 8 TCHs/TRU – 2 control channels = 14 TCHs. These 14 TCHs are at full rate, but it is common in GSM network to activate Half Rate (HR) of 80%. This results in perfect trade-off between capacity and voice quality. The total number of TCHs with 80% HR are now equals to 14 * 0.8 + 14 = 25.2 TCHs. With C = 25.2TCHs and given that a GoS of 2% is commonly adopted by the most of GSM operators, the offered traffic intensity from equation (3) or from Erlang B table (Mishra, 2007) is equal to A = 17.5 Erlangs. Based on the above analysis, the offered traffic can be theoretically calculated for each cell in the system. The offered traffic is then compared with the peak carried traffic obtained from the operational GSM network. Figure 9 shows the peak carried traffic versus the offered traffic for each cell in Jenien City after adopting a new configuration of the TRUs and consequently a new configuration of the TCHs. According to Figure 9, the offered traffic is always greater or equal to the peak carried traffic. This adds safety margin to the new proposed design. It is concluded that only 12 TCHs are required to carry the peak carried traffic. Figure 10 compares the old TCHs distribution with the proposed TCHs distribution per site. It is noted that 15 TCHs are configured for the sites JENI01 and JENI11, whereas only 12 TCHs are required to carry the peak traffic. A reduction of TCHs can also be made for site JENI02.

From the above results, as only 12 TCHs are required to carry the peak traffic, the number of BCCHs can be increased from 8 to 12 channels. This gives a total of 24 channels that are available for Jawwal GSM network. Increasing the number of BCCHs from 8 to 12 will reduce the co-channel interference as the spatial separation between the co-channel cells is increased. Indeed, the signal-to-interference (S/I) ratio or a mobile receiver which monitors a forward control channel can be approximated as (Rappaport, 2001)

$$\frac{S}{I} = \frac{Q^n}{i_0} = \frac{\left(\sqrt{3N}\right)^n}{i_0} \qquad (4)$$

where Q is the co-channel reuse ratio, $2 \le n \le 6$ is the path loss exponent whose value depends on specific wireless propagation environments (Rappaport, 2001), N is the cluster size, and i_0 is the number of first layer co-channel interfering cells. Thus, increasing the number of control channels will increase the co-channel reuse ratio and hence increasing the S/I ratio resulting in improvement of the QoS. It should be noted that the interference on control channels is more critical than that on the TCHs as it results in blocked or missed calls.

Figure 9 Peak carried traffic versus offered traffic for each cell of Jawwal GSM network in Jenien City (see online version for colours)

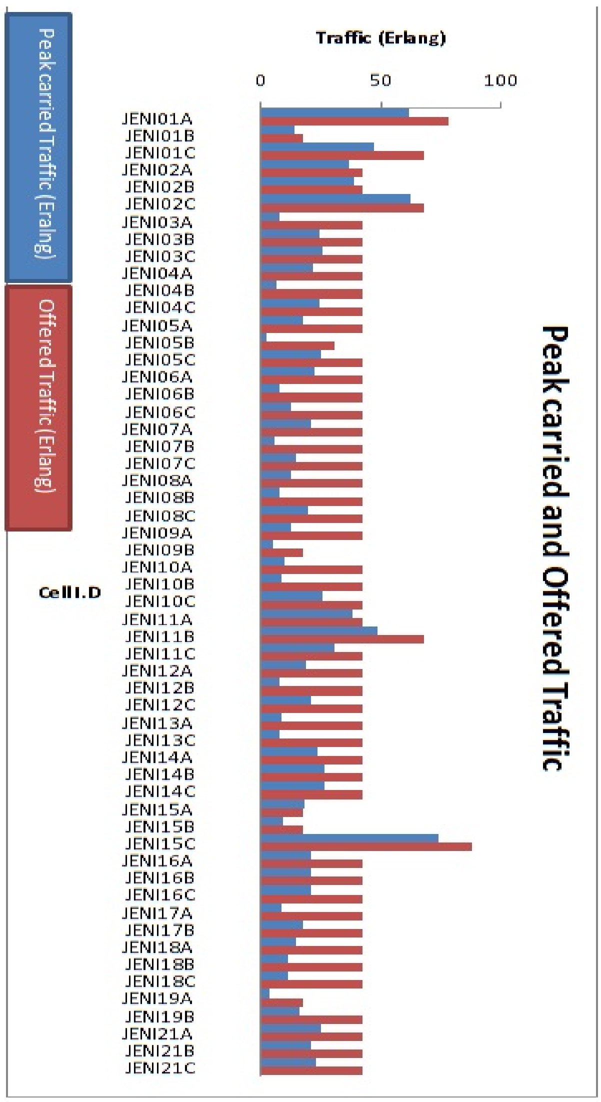


Figure 10 Current and proposed TCHs for each site of Jawwal GSM network in Jenien City

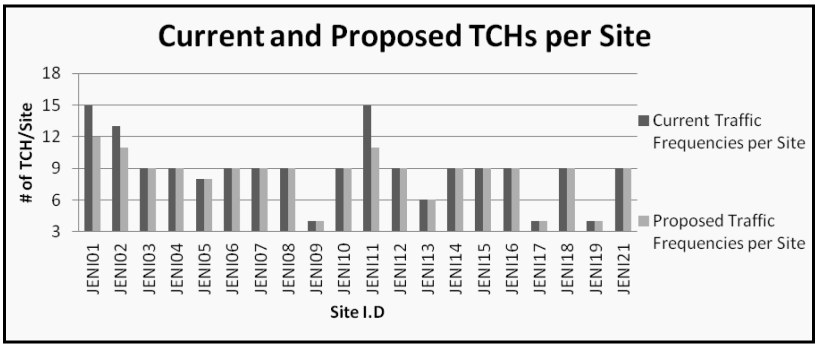


Figure 11 Proposed BCCH frequency reuse plan for Jawwal GSM cells in Jenien City using FAS (see online version for colours)

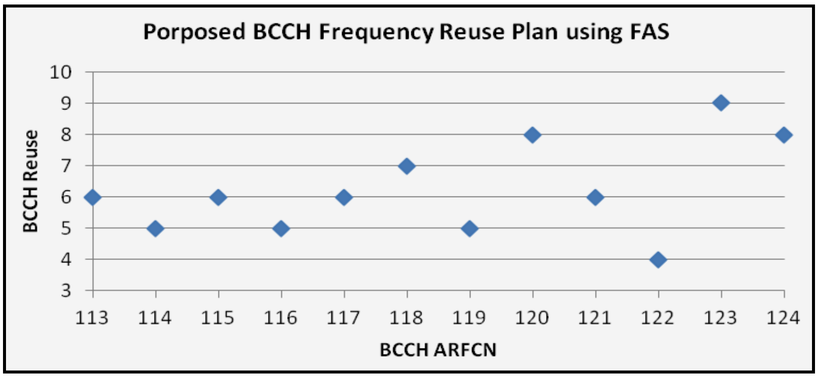
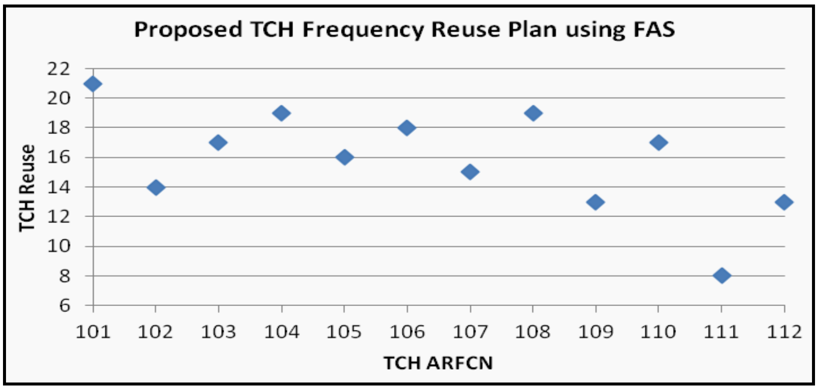


Figure 12 Proposed TCH frequency reuse plan of Jawwal GSM cells in Jenien City using FAS (see online version for colours)



An initial neighbour relation study is then made by considering the geographical location of the cells and on suggested mobility profile. The following rules are considered during this part of optimisation process:

1 Never assign the same BCCH to two neighbouring cells such as to avoid co-channel interference.

2 Avoid assigning adjacent BCCH to neighbouring cells such as to avoid adjacent channel interference.

3 Avoid using the same mobile allocation offset index (MAIO) in the cells that are very close to each other.

4 Must use different Hopping sequence number (HSN) for each site. This is applicable since there are 63 HSNs and there are only 21 sites in Jenien City.

5 Try to minimise the number of neighbour relation while considering the geographical location of each cell. This will boost the handover success rate and hence reduce TCH drop rate.

The obtained neighbour relation plan is then fed to the OSS optimisation tools discussed in the following subsection.

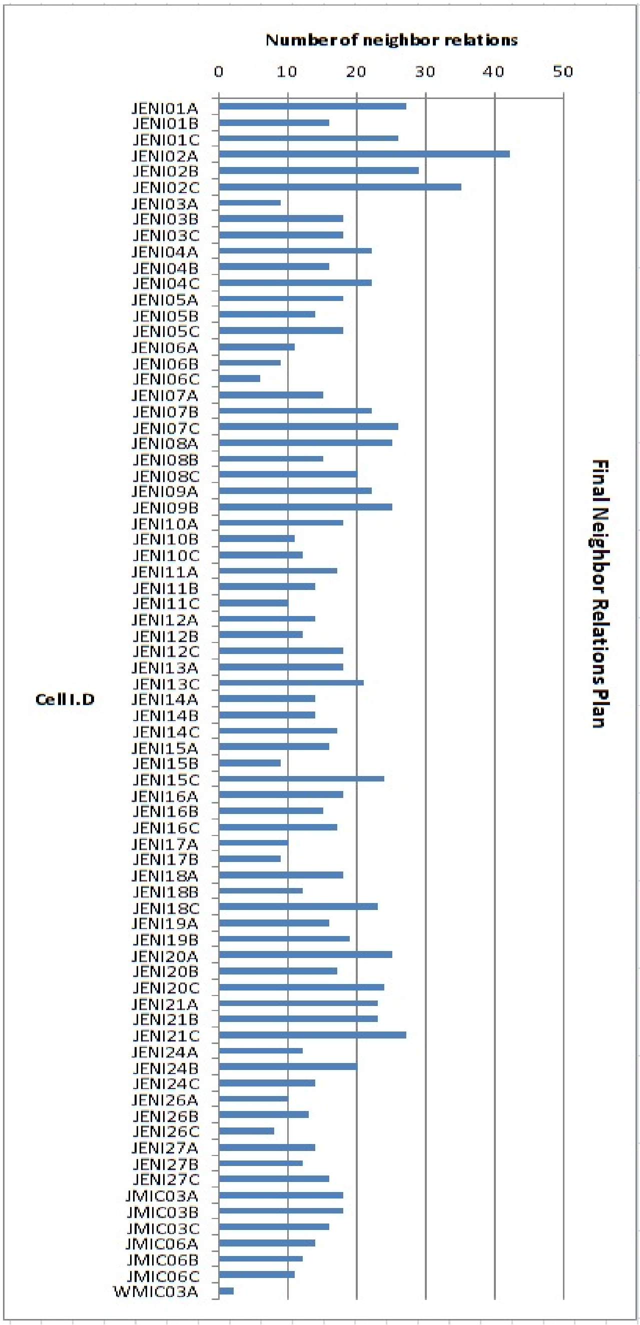
5.2 *Optimisation process using the OSS tools*

Two radio network optimisation tools are used in optimising the performance of the GSM cells, namely: frequency allocation support (FAS) and neighbour cell support (NCS).

5.2.1 Proposed BCCH and TCH frequency plans using FAS

FAS radio network optimisation tool is used to find the BCCH and TCH channels with lowest interference for every active cell in Jenien City. Figures 11 and 12 show, respectively, the proposed BCCH and TCH frequency plans that results in the lowest interference when using the FAS tool.

Figure 13 Proposed neighbour relations plan for Jawwal GSM cells in Jenien City using NCS (see online version for colours)



5.2.2 Proposed neighbour relation plan using NCS

Missing neighbouring cell relations result in more dropped calls and poor quality for the users. NCS is mainly used to find these missing neighbouring cell relations. NCS is also used to find unnecessary neighbouring cell relations that make the measurement less accurate. The problem of having missing neighbour relations is more critical than having extra defined neighbour relations. Figure 13 shows the proposed neighbour relation plan using the NCS tool.

6 Comparative study

In this section, a comparative study is carried-out between the performance of Jawwal GSM network in Jenien City before and after the optimisation process. More particularly, the drive tests and KPIs obtained, respectively, in August and November 2010 are compared with those obtained in October 2011.

6.1 Key performance indicators

The KPIs that will be analysed and compared are the TCH drop rate and Handover success rate. These two KPIs are the most critical for both the operator and the customer. Figure 14 shows the TCH drop rate comparison before and after network optimisation. It is noted that the TCH drop rate in October 2011 is less than that in November 2010. Indeed, the average TCH drop rate is reduced from 0.76% in November 2010 to 0.62% in October 2011. Figure 15 shows the handover success rate comparison before and after network optimisation. One can notice that the handover success rate in October 2011 is better than that in November 2010. Indeed, the average handover success rate is increased from 95.75% in November 2010 to 96.13% in October 2011.

6.2 Drive test

The most important parameters obtained from the drive test are the received signal level (RXLEV) and the received signal quality (RXQUAL). Table 5 shows the results of the drive test carried out in October 2011. According to Table 5, about 76.8% of the samples lie in level 1, which is the best level in terms of received signal level and signal quality. In addition, only 5.16% of the samples lie in level 4, which is the worst level in terms of received signal level and signal quality. When comparing the results in Table 4 with those in Table 5, a performance improvement is noticed. Indeed, the percentage of samples in level 1 is increased from 65.5% in August 2010 to 76.8% in October 2011. Furthermore, the percentage of samples in level 4 is reduced from 7.76% in August 2010 to 5.16% in October 2011.

7 Conclusions

This paper describes a case study about the performance evaluation and optimisation of GSM mobile network in Jenien City, Palestine. Two methods are used to evaluate the performance of the network, namely: drive test and KPIs. The comparative study on the performance of the network before and after optimisation showed significant performance improvement in terms of TCH drop rate, handover success rate, received signal level and received signal quality. Indeed, the average TCH drop rate is reduced from 0.76% to 0.62%. In addition, the average handover success rate is increased from 95.75% to 96.13%. Furthermore, the percentage of samples in level 4, which correspond to poor signal strength and poor quality, was reduced from 7.76% to 5.16%. Moreover, the percentage of samples in level 1, which correspond to excellent signal strength and excellent quality, is increased from 65.5% to 76.77%.

Figure 14 TCH drop rate comparison for Jenien City cells between November 2010 and October 2011 (see online version for colours)

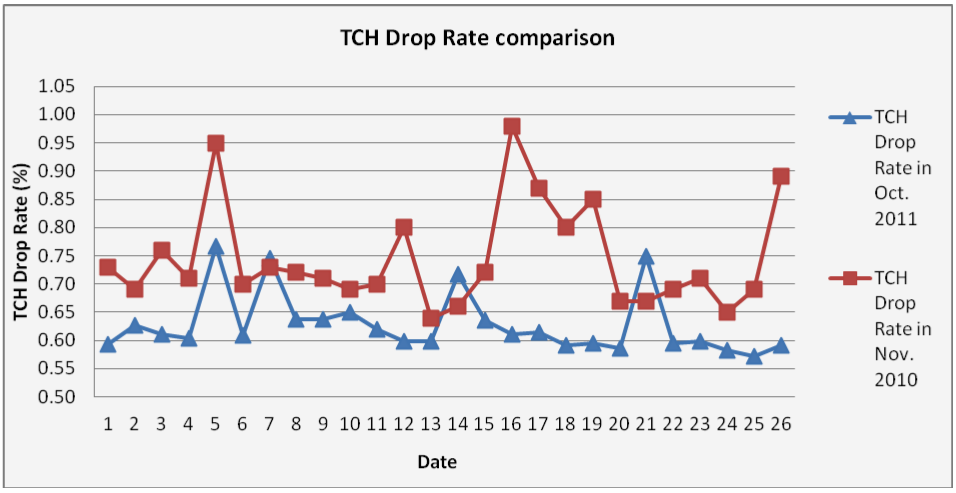


Figure 15 Handover success rate comparison for Jenien City cells between November 2010 and October 2011 (see online version for colours)

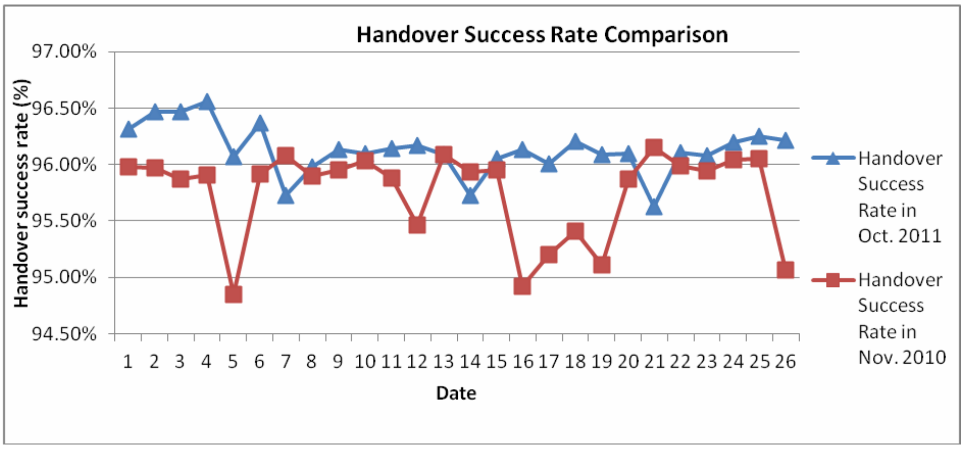


Table 5 Percentages of coverage classes of Jawwal GSM network in Jenien City by October 2011

RXLEV/ RXQUAL	*RXQUAL≤ 2*	*2<RXQUAL≤ 4*	*4<RXQUAL≤ 6*	*RXQUAL> 6*	*Coverage class*	*Total %*
RXLEV≥ –70	76.77	4.82	4.52	3.18	Level 1	76.77
–70 ≥ RXLEV≥ –85	5.71	1.17	1.69	1.81	Level 2	11.70
–85 ≥ RXLEV≥ –100	0.07	0.05	0.05	0.17	Level 3	6.38
RXLEV≤ –100	0.00	0.00	0.00	0.00	Level 4	5.16

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Notes

1 Palestine Cellular Communications Co., Ltd (Jawwal) is the first cellular operator in Palestine.

2 For information about Jenien City, see the following link: http://en.wikipedia.org/wiki/Jenin.

3 TEMS is Ericsson professional tool used for drive test data collection. For more information visit: http://www.ericsson.com/TEMS.

4 Actix software is professional software used as post processing tool for TEMS drive test log files. For more information visit: http://www.actix.com.