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Mobile Network Planning Process Case Study - 3G Network

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Abstract

Third Generation cellular networks (3G) were developedwith the aimof offering high data rates up to 2Mbps and 384Kbps for stationary and mobile users respectively which allows the operators to offer a multimedia connectivity and other data services to the end customers. In this work we apply techniques to design a 3G radio network, in particular we study the planning and implementation in developing countries, and state of Palestine as a case study. In order to carry a 3G radio network planning for a selected regions, wemust followa roadmap consists of set of phases; First of all, wemust determine the region under study on the digitized map in order to obtain some useful information, such as the area distribution; thus using digital maps gives a good clearness for areas classification, land use, land terrain, heights, vectors, etc. Also we must forecast subscriber profile to perform coverage and capacity dimensioning process to achieve nominal cell plan. This paper work studies Nablus as one of the major Palestinian cities. then, subscriber forecast profile is applied in order to calculate the service traffic demand, the capacity and and coverage requirements, this study is carried in corporation withWataniya which is one of the leading mobile telecommunication service provider in Palestine. For Nablus city we've found that 28 sites are required to be installed to meet the given capacity requirements, on the other hand 46 sites are for coverage. At this point we should make decision about how many site will be implemented. In general we have to select number of sites relative to coverage requirement; so to serve Nablus city by 3G services we should implement 46 sites. At final stage, we have to be sure that our proposed 3G network is suitable not only for the first year of running the 3G services over the deployed network, our design takes into consideration the growth of subscribers number and their demands, so periodically, the networking administrators and the network planning department, assess the network current status and upgrade the network to meet the future demands.

Keywords: 3G, Network Planning, Mobile Communication, Radio Network

1. Introduction

Cellular technology evolution has been started since 1950s, and the first commercial systems came in the late 1970s. Where cellular networks can be classified into different generations, namely, First Generation, Second Generation [**GSM**], Third Generation [**3G**] and Fourth Generation [**4G**]. In this paper we study the planning phases in order to upgrade the mobile operator network, to build a third generation in parallel with the current deployed second generation network. Many earlier works have been conducted regarding the 3G radio network planning i.e. [**book3G**], our study is related to the 3G planning and implementation for Nablus city, as one of the major Palestinian cities. The planning process have some main attributes and factors such as subscriber profile forecasting and the calculation of the service traffic demand, in addition to the capacity coverage requirements. This paper ends up with a proposed for an applicable 3G network to be deployed in the selected cities.

1.1 Motivation for Carrying Out this Research

It is worth to know that the Palestinian cellular network operators are still working on GSM/GPRS/EDGE (Global System for Mobile Communications/ General Packet Radio Service/ Enhanced Data Rates of GSM Evolution) that offers voice service and non matured data services. Nowadays, Palestinian subscribers are demanding more data communication services and aligned with the international subscribers demand. As figure 2 represents that GSM is already covered almost all over the world.

The telecommunication operators and providers followed accordingly. Third Generation is the next step for Palestinian, the implementation of the 3G in Palestine, is still not approved by the Palestinian MTIT (Ministry of Telecommunication and Information Technology) [MTIT]; that is typically due to political issues between Israel and Palestine. in all cases, the demand for 3G services become crucial, we have to be ready and have a study and road-map for the upgrading to 3G network, thus we are ready once the local mobile operators has got the permission to implement and run the 3G network service.

while figure 2 depicts the coverage of different mobile communication technologies; 2G, 3G and LTE (Long-Term Evolution) [LTE] based on the world map coverage for year 2015 [MAPWorld] [MAPVerizon], where we focus on the 2G and 3G technology coverage in the middle-east area.

As a result, we selected this topic to be aligned with the coming data evaluation in Palestine. This study will be very useful for the current operators to upgrade for the 3G network.

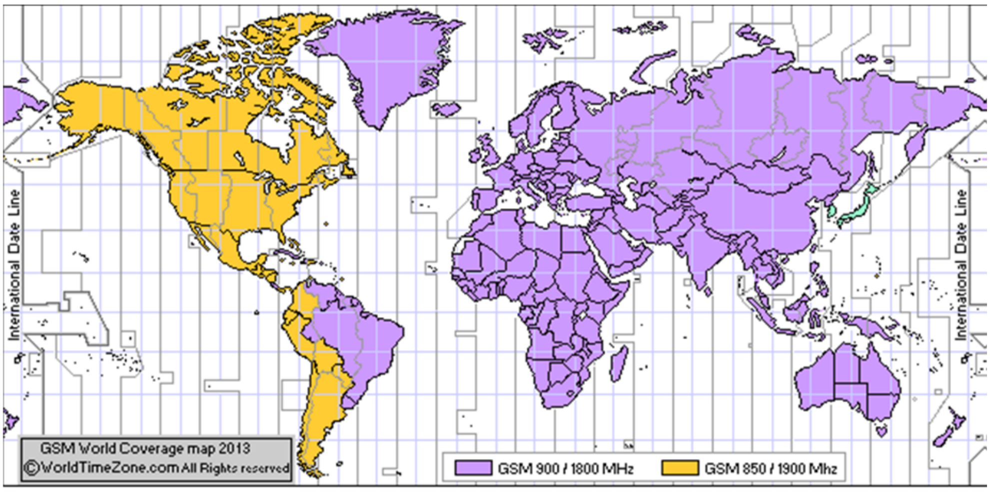

Figure 1. GSM World Coverage Map 2015

2. Literature Review and RelatedWork

In this paper, we outline the ”3G Radio Planning Design” in order to plan and design UMTS/3G (Universal Mobile Telecommunications System) network in Palestine. It provides design requirements and assumptions (e.g. service quality, link budgets, etc) that should be used for planning a UMTS network; the Radio network design process is outlined keeping in mind that Radio design will be an overlay on the existing 2.75G GSM network. Palestinian telecommunication mobile operators upon getting the approval and the permission to implement the 3G mobile technology, they have to design and deploy a UMTS network across all regions that will be capable of providing voice and packet data (including High Speed Packet Access HSPA) services to meet the rapidly data demand. The design will be an overlay on the existing GSM networks in Palestine to keep the current available infrastructure for the operational companies and to keep the utilization of current 2.75G services.

2.1 Third Generation Evolution

The wireless voice services started by the first generation circuit switched analogue service, which was for voice only; this technology did not provide SMS (Short Message Services) or other data services. Upgrading from first generation to Second digital system Generation (2G); this transition was posted due to several services provided by 2G technologies such as: data storing, coping, encryption and compression, and permits data transmission without loss be supporting error correction. Many other several cellular and wireless data services are provided in 2G networks, such as internet access, with speeds up to 14.4.kbps as a theoretical value. In addition, voice quality improved, even though, 2G is also circuitswitched, but this generation still not meets the required data rates and throughput compared with the demanded data volumes.

The Second generation technologies 2G, includes GSM (Global System for Mobile Communication) that is based on both time division multiple access mechanism (TDMA), and frequency division multiple access mechanism(FDMA), where a sectrum is divided into small slices, as well each slice is divided in time to multimple time slices, where users are allocated in turn to specific spectrum slice, and specific time slice as well.

Moving from 2G to 2.5G technologies, GSM/GPRS [GSM] [GPRS]; GPRS (General Packet Radio Services), that is a data-oriented technology extending the GSM voice services where GPRS theoretical can provide up to 200Kbps; which made an introduction to another revolutionary change. An enhanced GPRS is also introduced and named as EDGE which provides more data rate. The Third Generation cellular networks (3G) were developed with the aim of offering high speed data and up to 2 Mbps in the served areas or more which allow the operators to offer a multimedia connectivity and other data services to the end customers. A few technologies are able to fulfill the mentioned data rate such as CDMA (Code Division Multiple Access), UMTS and others. High Speed Packet data Access (HSPA) has been an upgrade to Wideband Code Division Multiple Access (WCDMA) networks used to increase packet data performance. The required

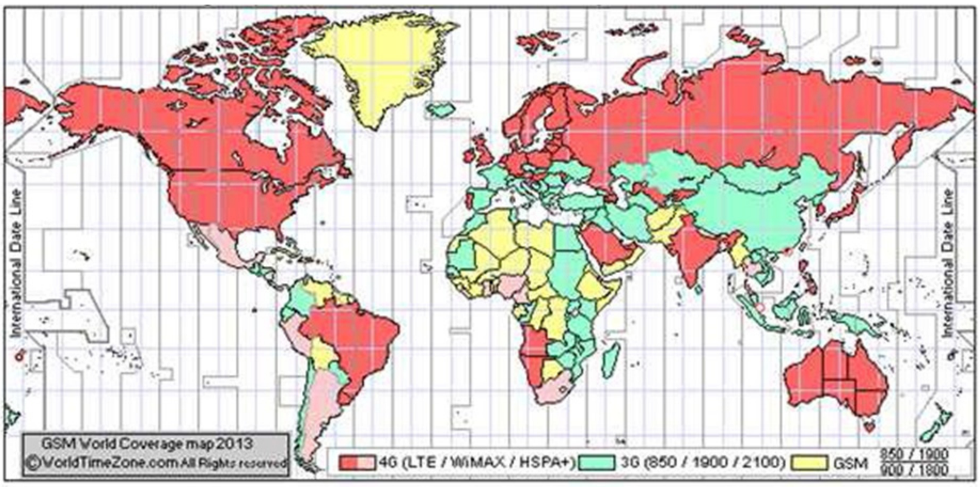

Figure 2. GSM, 3G, 4G World Coverage Map 2015

downloads and data volume demand has been recently increased per user. The HSDPA (High Speed downlink Packet Access) is developed to provide more data rates and up to 14.4Mbps to meet the users demand. HSDPA using different telecommunication techniques to increase the down-link data flow by developing different modulation and using MIMO (Multiple-Input and Multiple-Output)technology [MIMO].

Moreover, the upgrading to the Fourth Generation system 4G means that more data demand going to be booming during the coming decades, the fourth generation which called LTE (Long Term Evolution) is developed to meet the rapidly data demand.

The 4th generation still not utilizing major part in the market share due to the lack of devises that can support the LTE (Orthogonal Frequency-DivisionMultiple Access OFDMA) [OFDMA] technique and the existing network infrastructure required.

Nowadays, the LTE still supporting the data services only and not the voice, but it is in the process and development to support the voice also, after that, it will be called as ”advanced LTE”. The LTE can support more than 100 Mbps depends on the network structure and spectrum used.

2.2 Related Work

The first case study of 3G network in Europe, including the design and implementation was undertaken in Isle of Man, as the Manx Telecom 3G project [wu2015optimization], where all design and planning decisions were based on consideration of the desired end user experience, considering network quality, service coverage and performance of new data applications. Moreover, many other related works have been carried to study the 3G mobile network planning, where Guo et al., 2003 in [guo2003coverage] have studied the coverage and capacity calculations for 3G mobile network planning, where The planning process aims to allow the maximum number of users sending and receiving adequate signal strength in a cell. Moreover, the work carried in [amaldi2008radio] [tarapiah2015radio] has shown that the network planning process does not depend only on the signal prediction, moreover, it is not appropriate to depends on the classical second system generation in terms of formulas and parameters. Notwithstanding,mathematical programmingmodels for supporting the decisions on where to install new base stations and how to select their configuration (antenna height and tilt, sector orientations, maximum emission power, pilot signal, etc.) are discussed in [amaldi2008radio] [tarapiah2015common] which finds a trade-off between minimizing costs as well maximizing the covered area. In general the model take into consideration signal-quality constraints and requirements in both directions uplink and downlink, in addition to the power control mechanism and the pilot signal. More sophisticated work has been run, to automate the cellular planning process of the 3G network as being stated in [skianis2013introducing] [tarapiah2015advanced], some more important factors can be taking into consideration during the planning process, besides the coverage plan, and capacity pan, the Quality of Service QoS, resource utilization, and economical aspects have been considered in the work in [wu2015optimization]. In this work, we are going to state and describe full and complete methodology, design steps,and calculations for mobile planning of 3G network, on top of existing 2G network, for a given Palestinian city as a case study.

3. ResearchMethodology

This paperwork has been conductedwith the cooperationwithWataniyaMobile [WATANIYAH], The paperwork focuses on and discussing three major aspects of radio network planning and design which are: coverage, capacity, and Quality of Service (QoS). The designed methodology is requiring an advanced tools and procedure to accomplish the mentioned parties of the planning. WataniyaMobile offers the radio network planning tools to be used in their Head Quarter (HQ) and to support the idea and the techniques of capacity design and calculation, the QoS in theWCDMA [WCDMA] technology directly linked to the coverage and capacity design. To perform a complete 3G radio network design, we configured the radio planning tools to meet paper target and scope, the work include filling and configuring 3G radio capacity sheet to calculate and automate the capacity planning, moreover, to be more close to the actual design which started with nominal design, we did an actual site survey in addition to visit some selected sites of the designed ones based on the radio planning guidelines i.e. to match between the nominal and the actual sites location. At the end, we formulate the design based on the mentioned required important steps which include the coverage, capacity, and QoS steps. This will include the sub-actions like the propagation model, link budget calculations,... etc.

4. Design Procedure and Analysis

The process of designing the radio network is considered as one of the most important and crucial issue in the wireless design since it depends on many variables related to the land terrain, population density, allocated spectrum, and the target itself. The design process for any wireless system could have some common steps like the check list matrix, where figure 3 states the simple flow that will be followed during the planning and design for the 3G network, the design process can be enumerated as:

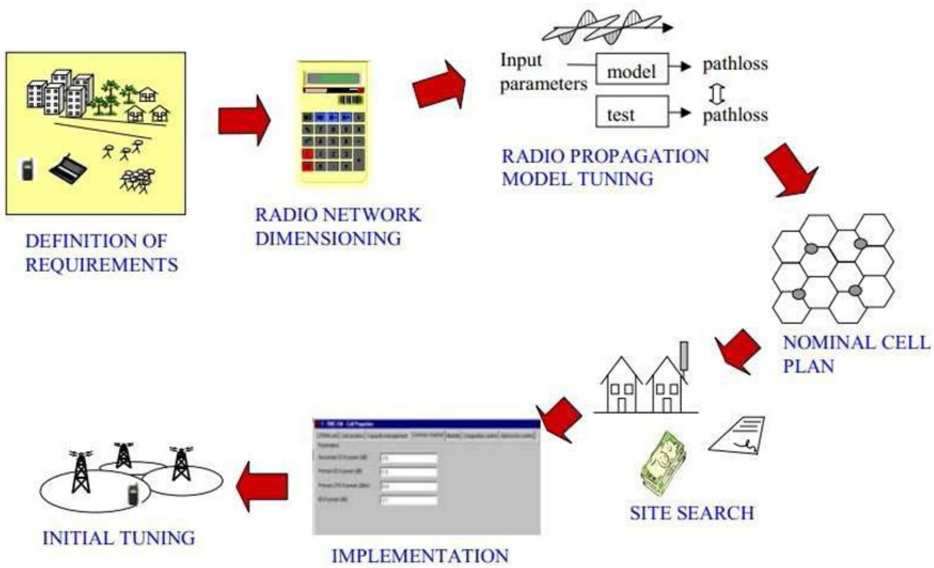

Figure 3. Radio Network Design Process

1. Definition of the Requirements: The first stage of the design process is to define the target required of the design, this stage holds surveying for an optimal solution and identifying the required tools and data to in order to start the designing and planning task i.e coverage percentage, forecasted number subscribers, subscriber traffic profile, ...e.t.c.

2. Radio Network Dimensioning: The next step, involves starting data mining, and to calculate the required capacity and equipments and tolls to meet the forecasted demand.

3. Radio Propagation Model Tuning: This stage concerns looking for the most important service Key Performance Indicators KPIs which is the coverage footprint, where the WCDMA coverage prediction depends on the loaded traffic, we have to allocate the mentioned step two traffic per sector to the tool in order to have better accuracy in the coverage prediction. The propagation model is one of the most important steps to be tuned and suitable for the land terrain to have the efficient coverage prediction.

4. Nominal Cell Planning: The planning tool is used to create a nominal cell plan by using the engineering sense and the tools features. The tools will support the engineering decision with many plots analysis related to the coverage, spectrum, and interference.

5. Site Survey: The cell planner, and site hunters, identify the suitable and applicable sites location that fits the radio coverage requirements. The site leasing/rental issues and the construction obstacles are also taken into consideration at this stage.

6. Implementation: This step includes all the sub-steps that are required for nominal cell planning. Whereas, planning tools could be used to evaluate many related parameters such as cell parameters, handover cell candidates, as well as the best location from Site Survey step,Antenna, RBS type, feeders,...etc are to be selected in this phase.

7. Initial Tuning: This step considers performing the drive test of the selected target area, where there are some available drive tests tools which can be applied in this stage, the outcomes and findings of the related target area measurements will be used further in order to tune the network to achieve the intended KPIs based on the design requirements.

4.1 Requirements Definition

The design requirements of the radio network include coverage, capacity and QoS, those requirements are related to different area types: dense urban, urban, suburban and rural during the design assumptions. In addition to these main area types, roads have to be considered due to their importance in the service continuity and traffic volume.

4.1.1 Area and Population

Most WCDMA networks are rolled out in phases, where for each phase of the network the number of km-square of each area classification (Dense Urban, urban, sub-urban, and rural and road) in addition to the subscribers distribution per area have to be defined and determined. Starting with Nablus city, and by using the digitized map that is typically supported by any planning tools (TEMS [TEMS] Cell planner are used in this project-it is a Swedish tool). The used digital map is created from high resolution satellite in 2015 and have 2 meter resolution which can be described as an accurate digital map, the used map have Palestinian land terrain, elevations, land use (urban, sub urban etc) and vectors (roads, main streets,...), figure 4 shows an example of Nablus city based on the available and the digital map in use for the land use purposes.

Table 1. Nablus city areas classification

Category	In Km-Square
Seasonal water bodies	0.01
Low tree	3.79
Open	9.23
Industrial/commercial	0.98
Buildings	0.02
Urban	1.03
Dense urban	0.92
Dense urban high	0.68
Suburban low	0.8

Suburban high	0.76
Residential	1.11
Open in urban	0.02
Parks	0.01
Agriculture	1.19

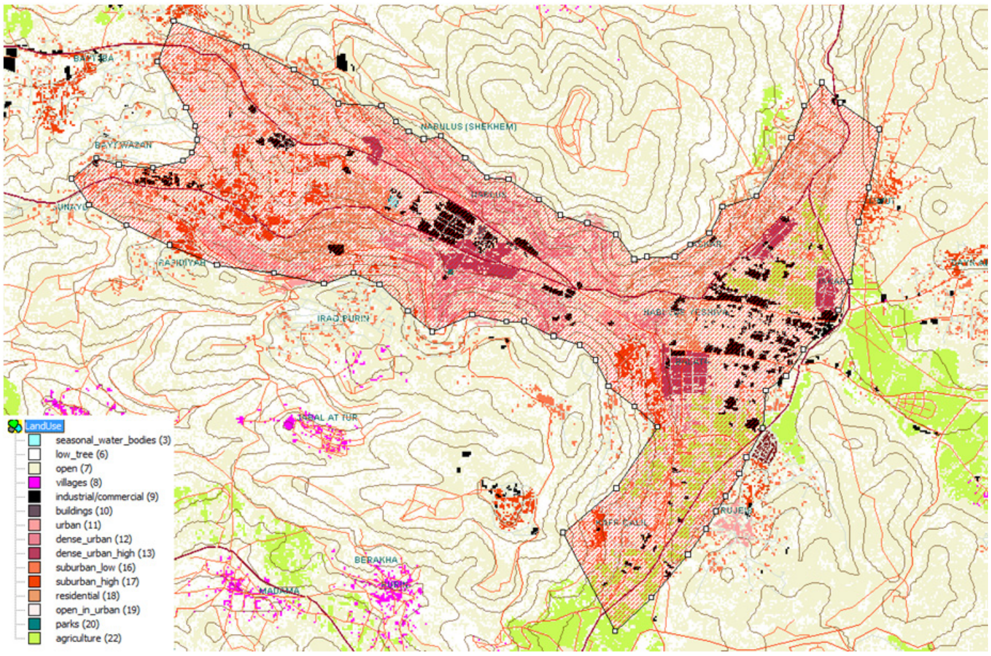

Figure 4. Nablus city in TEMS digital map

As per the digital map filtering, the area to be used for the planning issues will be 20.57 Km-square which could be classified as mentioned in the digital as stated in table 1.

According to statistics of the Palestinian Central Bureau of Statistics in 2015, Nablus city has 187,839 people, so we expect that the number of population in 2018 to be around 205,000 people based on the population growth in west-bank/Palestine. The design assumption is targeting to serves 30% of the population as a market share which means we will end up with 60,000 subscribers at the end of 2018.

4.1.2 Required Equipments

This section enumerates the required equipments for the implementation of the proposed 3G network, as being described:

1. Radio Base Station (RBS) Main remote Solution A Main Remote solution, optimized to deliver high radio performance for efficient cell planning in a wide range of indoor and outdoor applications. The Main Remote Radio Base Station, in which each Remote Radio Unit (RRU) is located near an antenna, reduces feeder losses and enables the system to use the same high-performance network features at lower output power, thereby lowering power consumption and both capital and operational expenditure. The Main Remote concept is designed to support all technologies in virtually any combination. The main Remote Solution is divided into a Main Unit (MU) and multiple Remote Radio Unit (RRU) that are connected to the MU through optical fiber cables. Where figure 5 shows RBS MU, Remote Radio Unit RRU and RBS 3-sector site respectively.

Figure 5. Ericsson RBS MU, RRU and 3-sector site respectively

2. Remote Radio Unit Remote Radio UnitWCDMA (RRUW) and Remote Radio Unit Standard (RRUS) are designed to be installed close to the antennas, and can be either wall or pole mounted. The RRUW has got WCDMA capability, and it is Multi Standard Radio (MSR) capable, that means RRUS is capable of running GSM, WCDMA and LTE on the same RRU hardware. The unit configuration can be done by software reload. The RRUS hardware is prepared for running mixed mode configurations, where RRUW and RRUS sustainable average output power is 60 Watt, for very large coverage and high capacity requirements. Dual band configurations are also supported by connecting RRUW or RRUS for different frequency bands to the same MU. The RRUW and RRUS contain most of the radio processing hardware. The main parts of the RRU are the followings:

• Transceiver (TRX)

• Transmitter (TX) amplification

• Transmitter/Receiver (TX/RX) duplex

• TX/RX filtering

• Voltage StandingWave Ratio (VSWR) support

• Tower Mounted Amplifier (TMA) and Remote Electrical Tilt (RET) support.

• Optical interface

Table 2. Antenna Specification

Frequency Range	1910 2170 MHz
Gain	17.2 dBi
Front to Back Ratio	more than 25 dB
Electrical Down Tilt (RET)	0-10 degrees

3. Optical Interface Link The RRU are connected to theMU through optical fiber cables, where units can be connected to each other in several different ways depending on the site setup. The RBS can supports the followings:

• Star connection of the RRU, where each RRU is connected to the MU.

• RRUWand RRUS can support cascade connections, where only one fiber cable is connected between theMU and one of the RRU, while other RRUs are then connected to each others, this solution reduces the length of the optical fiber cable needed and can be used in multiple applications when the RRU are located far away from the MU.

4. Antenna Configuration The antenna configuration recommended being able to configure different setups to cope with the strategic installation and keeping the existing infrastructure (co-located GSM and UMTS). All antenna configurations assume that the number of antenna ports available equals the number of feeder lines that can be installed. During the design we select antennas with specifications according to the project need and

selected area as stated in table 2

4.1.3 Traffic Requirements

Considering both area and population requirements, the traffic requirements will vary depending on the area type (dense urban, urban, sub-urban, rural and road). Whereas the percentage of subscribers using each service is used to calculate ”Average Subscriber Traffic Profile” as stated in the followings:

1. Speech Traffic Requirements: The subscriber Busy Hour (BH) traffic profile for speech must be calculated from the given requirements in terms of:

• Busy Hour Call Attempts (BHCA).

• Call Mean Hold Time (MHT).

• Grade of Service\Blocking Probability (GOS\P b).

while, assuming the existence of 50,000 subscribers in 3G network which will use speech service, the average subscriber traffic profile is equal to: (50,000/60,000)*100%=83%

2. Speech Traffic Requirements calculation: By assuming that BHCA = 0.5 and MHT = 3 min = 0.05 hours. Traffic (Nablus) = BHCA X MHT. Traffic (Nablus) = 0.5 X 0.05 = 0.025 E = 25 mE. Average Subscriber Speech Traffic = 25 X 83% = 20.75 mE.

3. CS64 Traffic Requirements: The subscriber Busy Hour (BH) traffic profile for CS64 is to be calculated based on the following given requirements in terms of:

• Busy Hour Call Attempts (BHCA).

• Call Mean Hold Time (MHT).

• Grade of Service\Blocking Probability (GOS\P b).

While, assuming that 10,000 subscribers to be exists in 3G network which will use CS64 service, the average subscriber traffic profile is to equal: (10,000/60,000)*100%=17%

and by assuming that BHCA = 0.1, and MHT = 6 min (= 0.1 hours). Traffic (Nablus) = BHCA X MHT. Traffic (Nablus) = 0.1 X 0.1 = 0.01 E = 10 mE. Average Subscriber Speech Traffic = 10 X 17% = 1.7 mE.

Table 3. Network Requirements

Service	Dense Urban	Subscribers using Service
Speech BHCA	0.5	83%
Speech MHT	3 min	83%
Speech Speech GOS	2%	83%
CS64 BHCA	0.1	17%
CS64 MHT	6 min	17%
CS64 GOS	2%	17%
R99 PS UL Traffic [Kbyte\h]	6	67%
R99 PS DL Traffic [Kbyte\h]	60	67%

4. PS Traffic Requirements: The term ”PS Traffic” is used to distinguish between Third Generation Partnership Project (3GPP) Release 99 (R99 or UMTS) data services which have a maximum rate of 384 kbps and High Speed data services that employs High Speed Downlink and Uplink Packet Access channels (HSDPA/HSUPA) [HSDPA]. The subscriber Busy Hour (BH) traffic profile for R99 PS have to be calculated from the given requirements in terms of:

• Uplink Traffic Volume [Kbyte\h].

• Downlink Traffic Volume [Kbyte\h].

when, assuming that 40,000 subscribers in 3G network will use PS R99 service, the average subscriber traffic profile is equal to:

(40,000/60,000)*100%=67%

5. R99 PS Traffic Requirements:

This requirement is already given in Kbyte\h, and we assumed that the uplink traffic is 10% of the downlink.

Average Subscriber R99 DL PS Traffic = 60 X 67% = 40.2 Kbyte\h. Average Subscriber R99 UL PS Traffic = 6 X 67% = 4.02 Kbyte\h.

4.2 Radio Network Dimensioning

During the design, we use Ericsson Radio Network Proposal Tool (RNPT) to perform R99 dimensioning and preparing the Bill of Quantity (BoQ), which details the hardware required to implement the radio network design, this information can be used for pricing purpose. We can summarize this process into the following steps:

Step 1 Calculating the limitation on the capacity on basis of the maximum allowed traffic load on both directions; uplink and downlink.

Step 2 Based on the available given number of sites, compute and determine the actual cell load on both directions; uplink and downlink.

Step 3 Calculating the interface margin at uplink (B IUL) and ensure it is greater than 0 dB.

Step 4 Calculating the required power at the Common Pilot Channel (CPICH) at the reference point (C (PICH,ref)) take into consideration, that the power must be less than 10% of the nominal power at the reference point (P (nom,ref)).

Step 5 Calculating the total power at the reference point (P (tot,ref)) and check that it must be less than 75% of nominal power at the reference point (P (nom,ref)).

Step 6 Calculating the required power at themaximumtransportDedicated Channel (DCH) at the reference point (P (DCH,ref)), where the calculated power must be ess than 30% of the nominal power at the reference point (P (nom,ref)).

Table 3 states the network requirements for Nablus city, based on the output and findings from the R99 dimensioning process, where the maximum load should not exceed 70% and 76% uplink and downlink direction respectively.

4.2.1 Dimensioning Process Step 1 (Capacity)

based on the RNPT Cell Load Calculator on the "Tools" sheet, the findings show that the maximum number of users supported 70% uplink load as shown in figure 6,

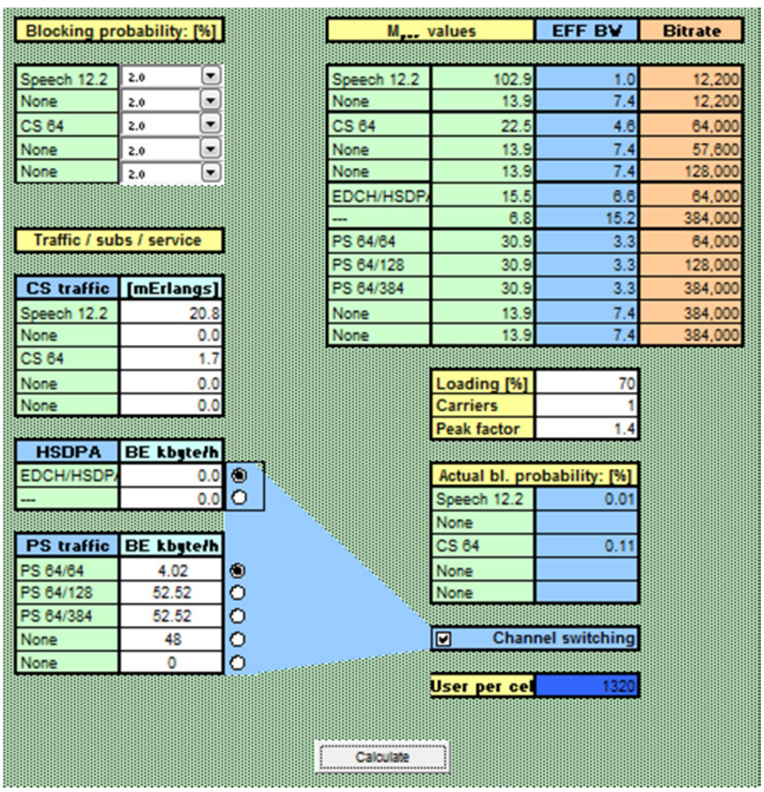

Figure 6. Number of Uplink Capacity Sites

where the outputs states 1320 subscribers per cell, thus in order to serve 60,000 subscriberswhichmeans that 60,000\1320 = 45 cells or 45\3 = 15 sites. The number of subscribers supported in the downlink at 76% load can also be calculate using the RNPT cell load calculator as shown in figure 7,

where the findings show that 1335 subscriber per cell, thus in order to serve 60,000 subscribers thismeans that 60,000\1335 = 45 cells or 45\3 = 15 sites. Based on capacity requirements at least 15 sites or 45 cells are required each for serving 60,000 subscribers.

4.2.2 Dimensioning Process Step 2 (Cell Load -15 sites)

Estimating the uplink and downlink cell load based on the number of subscribers, this can be performed by entering and increasing the input parameter load values until the targeted required number of subscribers per sector is produced as shown in figure 8,

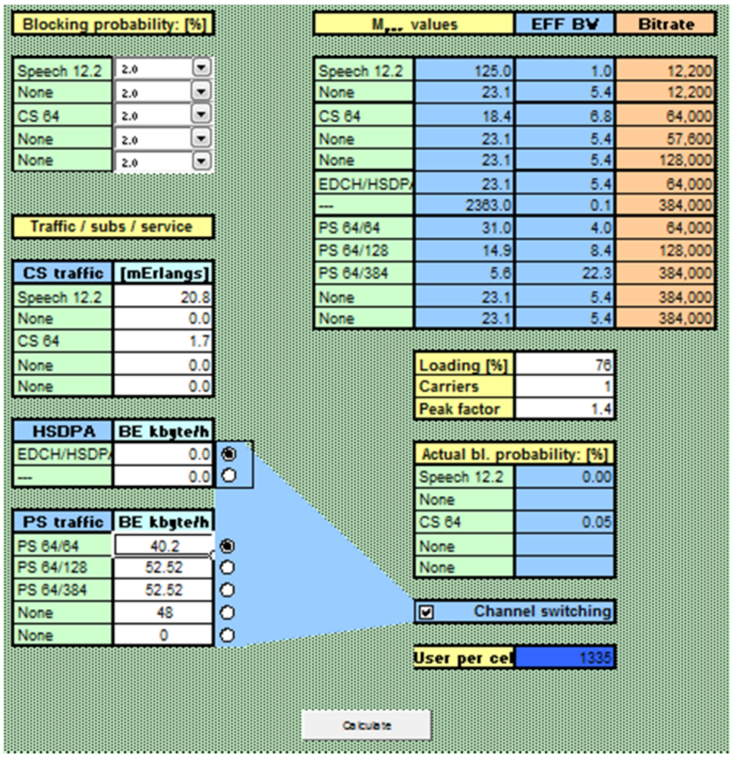

Figure 7. Number of Downlink Capacity Sites

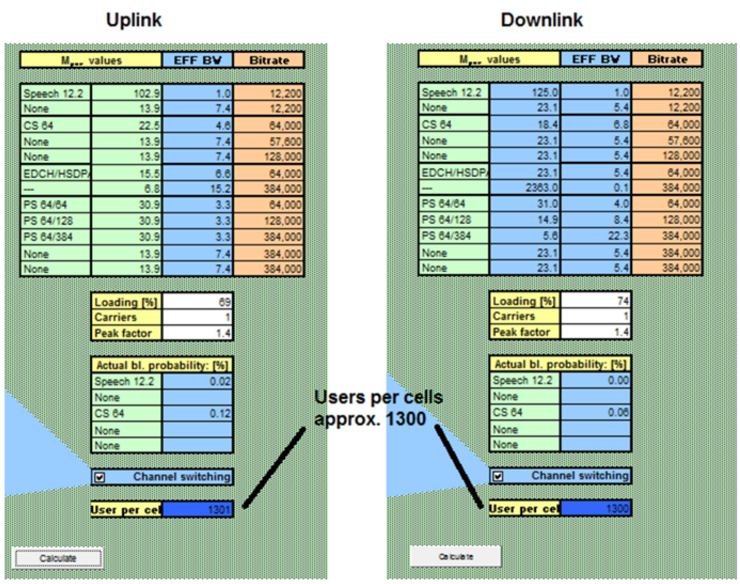

Figure 8. Uplink and Downlink Cell Load

when 15 sites is defined, the uplink load is 69% and the downlink load is 74%.

4.2.3 Dimensioning Process Step 3 (UL Interface 15 sites)

in order to find the uplink interface margin, the cell range must be performed earlier based on the formula 1.

$$R = \sqrt{\frac{8 \times CoverageArea}{15.59 \times N_{sites}}}\left[KM\right]$$

$$R = \sqrt{\frac{8 \times 20.57}{15.59 \times 15}} = 0.84\left[KM\right] \tag{1}$$

Moreover, cell range can be used to determine the maximum uplink interference margin, as well the guaranteed load as depicted in figure 9

Service type	Speech 12.2
Thermal noise power density	-174.0
Noise figure	1.3
Eb/No	4.3
User rate	15600
RBS Sensitivity	-126.45
Cell range	0.84
BS antenna height	25
MS antenna height	1.5
Okumura - Hata: A parameter	155.1
a(Hm)	0.00
a (a + b log10(d)) [d in km]	134.00
b (a + b log10(d)) [d in km]	35.22
Attenuation A	135.78
Attenuation B	3.57
Pathloss	133.07
Results of selected services	
Maximum interference margin	0.43
Equivalent R99 Load	9.48
Requested R99 Load	

Figure 9. Maximum Uplink InterferenceMargin-1

Site Number Iteration (Increased from 15 to 28): Unfortunately, the maximum interference margin is 0.43 dB ¿ 0, but the uplink load here is less than 69%, thus we have to increase the number of sites, where the uplink load increases, the cell range decreases. So, by increasing the number of sites in in the earlier dimensioning process phases, we will have a number of sites equal to 28 sites and a cell range of 0.61 Km, also the load increase to 71.15% and the maximum interference margin will be 5.4 dB ¿ 0 as shown in figure 10

Service type	Speech 12.2	
Thermal noise power density	-174.0	
Noise figure	1.3	
Eb/No	4.3	
User rate	15600	
RBS Sensitivity	-126.45	
Cell range	0.61	
BS antenna height	25	
MS antenna height	1.5	
Okumura - Hata: A parameter	155.1	
a(Hm)	0.00	
a (a + b log10(d)) [d in km]	134.00	
b (a + b log10(d)) [d in km]	35.22	
Attenuation A	135.78	
Attenuation B	3.57	
Pathloss	128.11	
Results of selected services		
Interference margin	Not selected	Not
Maximum interference margin	5.40	
Equivalent R99 Load	71.15	

Figure 10. Maximum Interference Margin-2

4.2.4 Dimensioning Process Step 4 (CPICH Power 28 sites)

The CPICH power can be calculated using the tools as shown in figure 11,

DL MARGIN	15.1
Max. power at syst. Ref. Point	9.6
DL Interference margin	4.3
Received Signal Code Power (dBm)	-116.3
CPICH power [dBm]	26.9
CPICH power [W]	0.5
Average CCH power [W]	1.24
Peak CCH power [W]	2.85
CPICH power / Ptotal ref.	5.12%
Average CCH power / Ptotal ref.	13.02%
Peak CCH power / Ptotal ref.	29.89%

Figure 11. CPICH Power

it is clear that at the range of 0.61 Km, the CPICH power test passes, that the CPICH power is less than 10%.

4.2.5 Dimensioning Process Step 5 (Total Power 28 sites)

The total downlink power calculation can be performed using the ”DL total power calculations” for the calculated cell range and load, as stated in figure 12.

DL load	14
DL Mpole	125.0
DL Number of cells	3
Area factor	0.6495
gamma (C/I)	0.0075
Noise (No*W*NF)	5.453E-14
Attenuation A	135.78
Attenuation B	3.57
Tabulated integral (phi)	1.083
SHO	1.108
H (noise term)	2.377E-15
Used average CCH power	1.24
Total DL power	2.95
Selected Total DL power	2.95
Maximum total DL power [W]	2.95
Maximum total DL power [dBm]	34.70
Max. total DL power / Ptotal ref.	30.87%

Figure 12. Total Downlink Power

It is clear to notice that the total power downlink power is less than 75% of the nominal power at the reference point (P (nom,ref)).

4.2.6 Dimensioning Process Step 6 (Maximum DCH Power 28 sites)

The maximum DCH power calculation can be performed using the ”DL DCH power calculations” for the calculated cell range and load as depicted in figure 13,

DL DCH power calculations	
Maximum DL DCH power [W]	0.52
Maximum DL DCH power [dBm]	27.16
Max. DL DCH power / Ptotal ref.	5.44%

Figure 13. Maximum Downlink DCH Power

as this stage represents the last step in the dimensioning, the maximum DL DCH power is less than 30% of the nominal power at the reference point (P (nom,ref)). So we will end up with number of sites equal to 28 sites, with a cell of range around 0.61 Km.

4.3 Radio Propagation Model Tuning

The 3rd Generation Partnership Project (3GPP [3GPP]) and Third Generation Partnership Project 2 (3GPP2) industry alliances jointly developed channel models that are to be used for the evaluation of cellular systems with multiple antenna elements. The models are defined for three environments, namely urban microcells, urban macrocells, and suburban macrocells. The model is a mixed geometrical stochastic model that can simulate a cellular layout including interference, where as one of the most important steps is to tune the propagation model in order to get the best model parameters, that fit the land terrain to have the efficient coverage prediction, during the cell planning process, radio cell planning tool is used to predict the radio coverage by means of propagation models, for a particular site configuration. Different propagation models are considered according to the different environments and site configurations. The Algorithm 9999 model [R9999] is without knife-edge and spherical earth loss contribution implemented by Ericsson and based on the Okumura-Hatamodel [hata] which is the best suited for large cell coverage (distances up to 100 km) and it can extrapolate predictions up to the 2GHz band. This model has been proven to be accurate and is used by computer simulation tools. The earlier mentioned propagationmodel is the one adopted byWataniyaMobile. Themodel tuning (model calibration) is performed in order to obtain more reliable radio propagation predictions. Measured and predicted signal strength samples are compared, and the mean error between them is minimized.

4.4 Coverage and Nominal Cell Planning

The service footprint and availability is the most important key Performance Indicators (KPIs) in any wireless technology, this KPI determine if the end customer can access the network or not. In order to meet the design required coverage area, we have to classify and study the areas aspects i.e. population, building types, land terrain, ... all the mentioned issues need advanced tools to automatically iterate the calculations. In this work, we used advanced tools to support our network design goals which are provided byWataniyaMobile for the target of this study. The tools can predictmost of the required engineering analysis i.e. technology coverage, equipment infrastructure configurations, and required and accepted level of signal noise. Thus, in order to cover Nablus city with 3G services, we end up with 46 sites., where figure 14, and figure 15 represent the coverage sites distribution using cell planning tool and Google Earth software respectively:

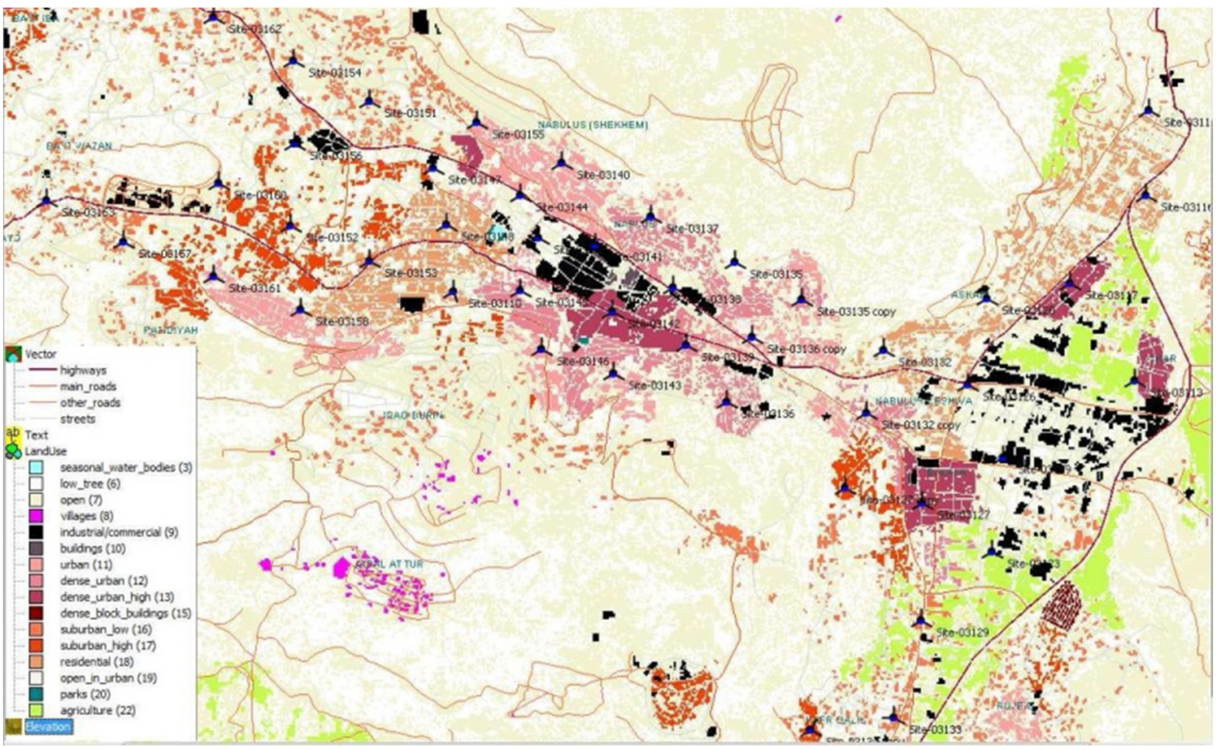

Figure 14. Coverage Sites Distribution according to Cell Planning Tool

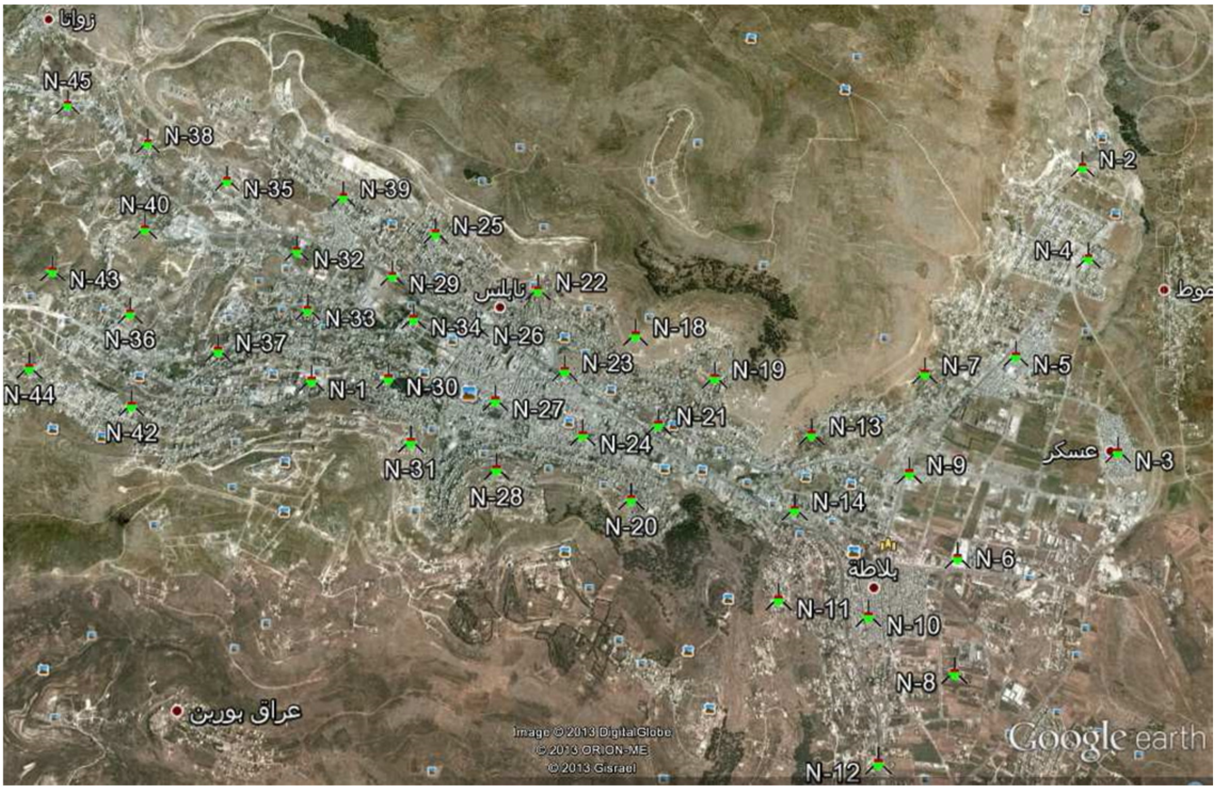

Figure 15. Coverage Sites Distribution according to Google Earth

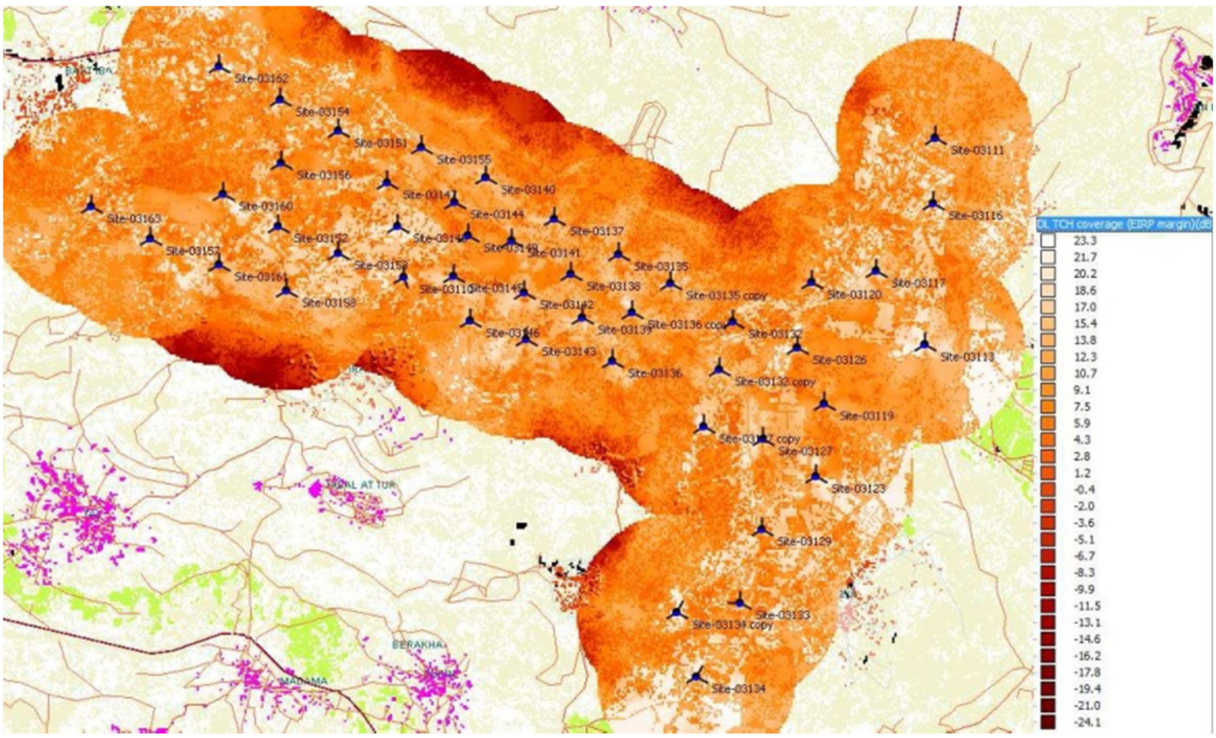

Figure 16. Downlink Traffic Channel Coverage

Various coverage plots and analysis can be prepared by cell planning tool to ensure that our plan meets the requirements; Where figure 16,17,and 18 represent each of downlink traffic channel coverage, handover and downlink total interference respectively.

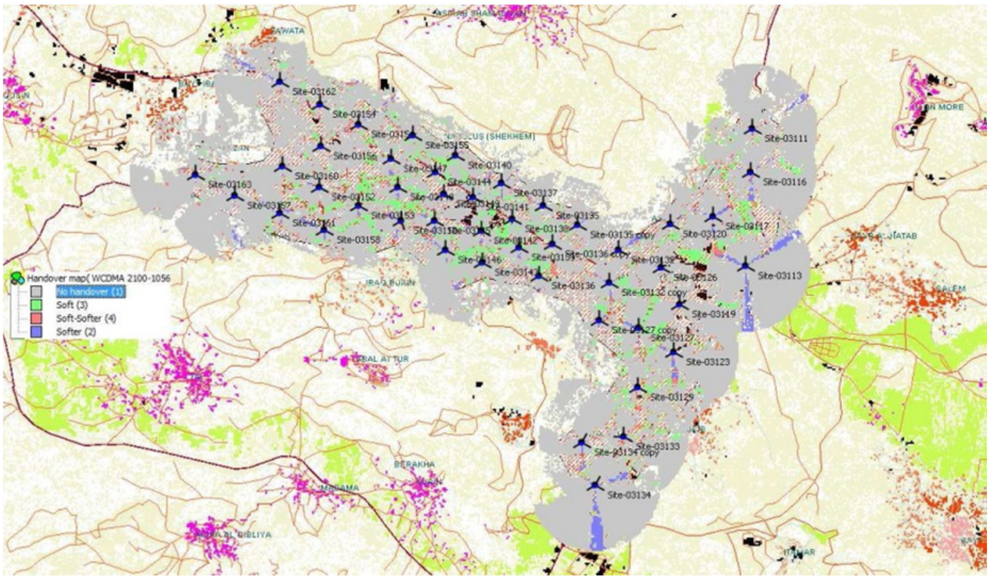

Figure 17. Hanover

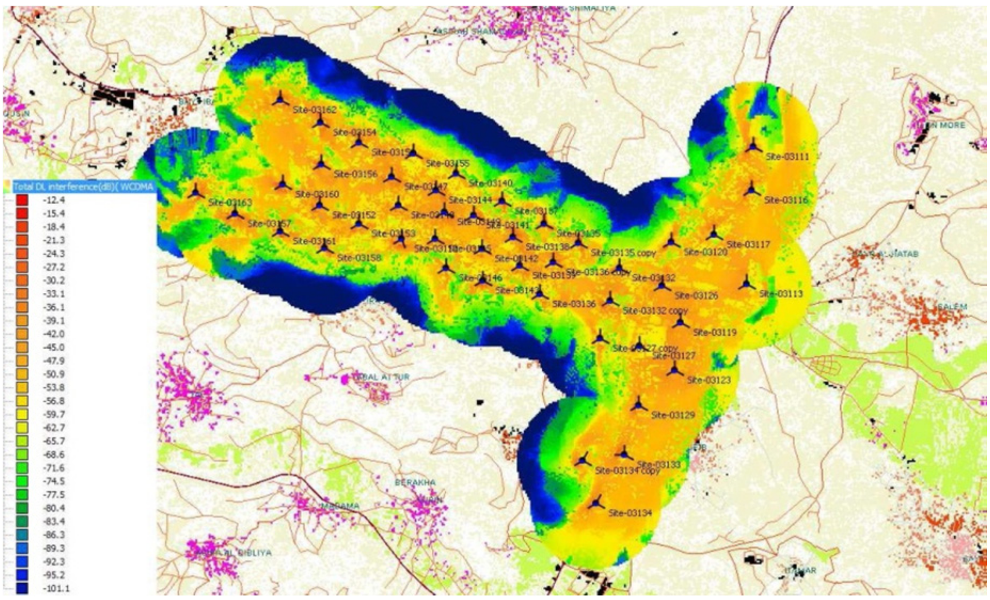

Figure 18. Downlink Total Interference

4.5 Site Search and Survey

After designing the radio nominal points, the ideal scenario is to install the sites based on the exact location outcome from the planning tool, but in reality it usually it differs due to the geographical constraints, streets, houses, and some other environmental factors, thus site survey is to to be performed which translates the ideal solution to be an actual solution, and mostly we will shift or move the nominal points into near points due to ground obstacles i.e. leasing problem, nominal points locates in a middle of major street, not accessible piece of lands, no electricity, or any other arising constraints that may appear in site. Continuous refining and re-planning tasks will be accomplished during the site survey to maintain the major coverage objectives. The basic concepts of the ”Site Survey” are very simple, where it intends to indicate one or more points as possible candidates, as shown in figure 19which in fact represent the selected site number 34 to visit.

Figure 19. Site Number 34 at Nablus City

More alternative sites is preferred to be considered, which allow a better margin for trading in the area responsible for this engagement. This is because, may be the first indicated point has many problems to be installed in that location such as the proprietary owner do not want to allow the operator to use his proprietary or any other constrains transmission problems, unavailability of infrastructure,.. etc. In order to avoid these constraints, the ”Site Survey” stage will be conducted together with the areas of RF, Transmission, and Infrastructure, Contract.

4.5.1 Required Equipments for Site Survey

There is not a mandatory rule about what equipment to have in the site, but here’s a little ”Check List” with the main equipment desired. As always, everything depends on what is needed, as it may depend the ’Survey’ type, Region,... etc. We could use during our work in the site survey the followings:

1. GPS [GPS] In order to define the geographical location based on the longitude and latitude coordinates in addition to altitude, a Global Positioning System GPS device is used in the site, where figure 20 shows the GPS device used in the selected sute 34.

Figure 20. GPS Device

2. Camera usually in the site, some photos are required, especially to have the panorama view of 360 degree, the

captured photos may be used for further analysis. the photos is illustrative, and various other factors must be taken into account in this decision, but in general, not having a limited vision, and get a macro view always helps to get the best result. 21 shows 360 degrees divided by 30 to 30 degrees photos for N-34 site chosen as nominal point.

Figure 21. 30 to 30 degrees photos for N-34 site.

3. Compass In order to determine the orientation of azimuths, a compass with north orientation is used as depicted in Figure 22.

Figure 22. Compass-North Direction/0 degree

5. Conclusions

Advances in technology have lead to massive data communications, telecommunication operators need to cope with this evolution; so new technologies are being applied to satisfy customers need. 3G is one of the candidate technologies that supplies customers with high data rate and throughput. Several phases are considered to apply 3G radio design in any region, first of all, a region must be determined to be subjected to study on the digitized map in order to obtain some useful information such as the area distribution; this gives a good clearness for areas classification, land terrain, heights, vectors, and some other parameters. Therefore, propagation model is determined and defined along with the link budget, capacity and coverage calculations, as a result of this process; the nominal cell planning is produced. The design of the network architecture have to capable to accommodate with increasing population and subscriber data demands, so the network can be upgraded to maintain it services and sustainability.

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