Design The Amount Of Error Due To Free Space Loss Model Used By Telecommunication Companies

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Abstract: Metropolitan Area Networks (MAN) represented by mobile users and towers is our interest in this project. However, with this wide range of vital uses of mobile communication, best spectrum utilization is the most important issue that scientists in wireless communications have to deal with. Accordingly, this project will consider the free space propagation model used by local companies. Sulaimanyia City map will be used as a case study. Matlab program will be our tools to analyze the effect of Free Space Propagation Model on several locations is Sulaimanya. Different clutter loss scenarios will be assumed to find the amount of error in several locations on the city map. Actual parameters of transmitters and Receivers will be collected from Asia Cell Engineers. The paper will be mainly focused on finding the percentage of error on map and validate the results using ICS Telecom Software.

Index Terms: GSM, free space, ATDI, Propagation Model, Towers, system Spacifications.

1 INTRODUCTION

Radio waves in GSM are generally vertically polarized, but the plane maybe rotated due to reflections. This can be used to provide diversity reception, vertical and horizontal polarization maybe used to isolate microwaves signals in transmission links. Radio spectrum is a limited source and controlled internationally by ITU and Europe by ETSI, for mobile communication we are using this following range

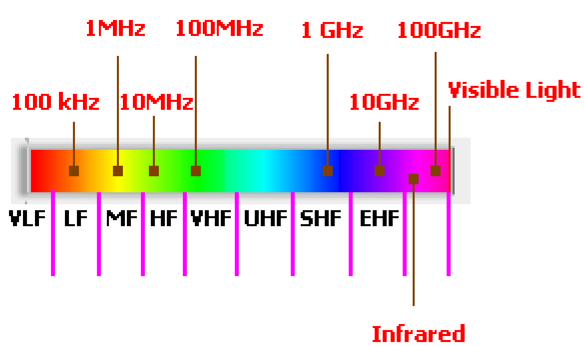

Fig. 1 *Spectrum Plan*

Marconi invented the wireless telegraph in 1896, where communication by encoding alphanumeric characters and analog signal sent telegraphic signals across the Atlantic Ocean. In 1914 – First voice communication over radio waves. While communications satellites launched in 1960s. Then after, an advances era in wireless technology began starting with Radio, television, mobile telephone, communication satellites Satellite communications, wireless networking, and cellular technology.

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Transmitting voice and data using electromagnetic waves in open space. Electromagnetic waves travel at speed of light (c = 3x108 m/s)
Has a frequency (f) and wavelength (l)

$c = f \times l$ (1)

In this case we have five types of GSM spectrum allocation:
In primary spectrum we have UPLINK sub band: 890MHz to 915MHz , DOWNLINK sub band: 935 MHz to 960 MHz.

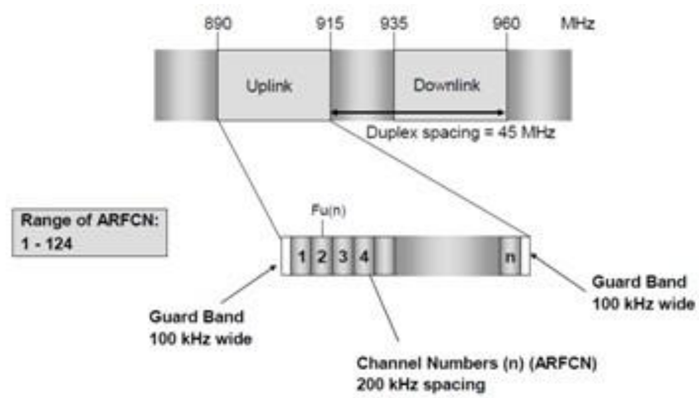

Fig.2 *P-GSM spectrum (primary GSM).*

Here we have UPLINK sub band: 880 MHz to 915 MHz. DOWNLINK sub band :925 MHz to 960 MHz.

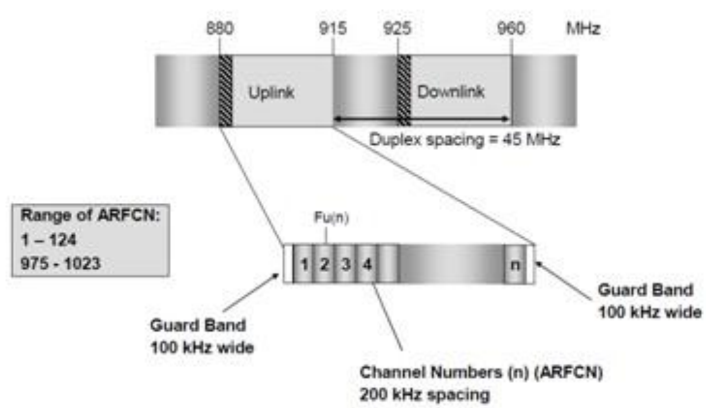

Fig. 3: *E-GSM spectrum (Extend GSM).*

DCS-1800 spectrum:
Duplex sub bands of width 75 MHz- Duplex spacing 95 MHz,
UPLINK sub band: 1710 MHz to 1785 MHz.
DOWNLINK sub band: 1805 to 1880 MHz.

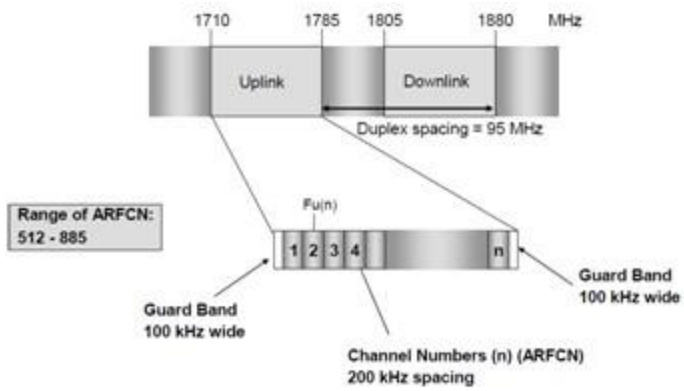

Fig. 4: *DCS-1800 spectrum.*

Personal communication system-1900 MHz, Duplex sub bands of width 60MHz – Duplex space 80 MHz.
UPLINK sub band: 1850 MHz to 1910MHz.
DOWNLINK sub band: 1930 MHz to 1900MHz.

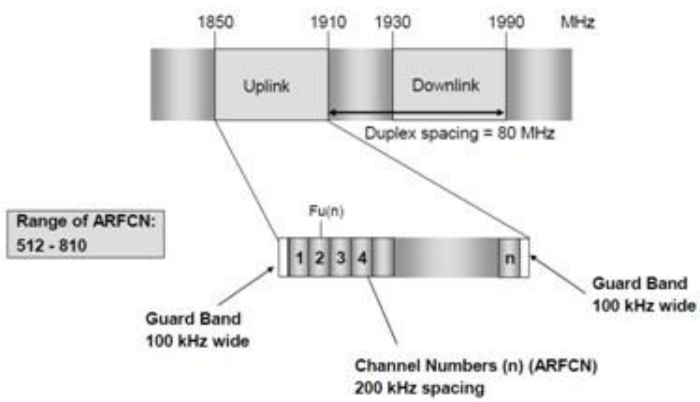

Fig.5: *PCS-1900 spectrum.*

The Aim of this paper in general is to use different clutter loss scenarios, to find the percentage of error on map and validate the results using ICS Telecom Software, and Sulaimanyah City map will be used as a case study. Analyze and simulation network to check the ability to distribute modern network in a map has similar environment like Sulaimanyia City. Considering The Clutter Loss effect given by ITU432-14 Document. A number of studies have been conducted to analyze and measure the potential unwanted transmissions (and/or emissions) from 2nd G systems to other technologies and vice versa. For instance, typical GSM network capacity losses due to in-band and adjacent channel interferences in the 900/1800 MHz bands have been reported by [1], [2], respectively. Since GSM is the most popular network till now world widely, we found base on literature that GSM Network would be the best scenario for this Project. To account for several enabling/disabling factors of coexistence issues, a combination of several parameters is established here. The proposed approach can find applicability in any kind of 2nd Generation systems, though GSM networks are merely considered. And that will be definitely using ATDI Telecom and Matlab Programming. The radio frequency spectrum is an essential but limited non-replicable natural resource in a sense the raw material of wireless telecommunications. The explosive growth and continuous increase in number and popularity of wireless communication systems has led together with the emergence of new services to an increased demand for more spectrum. Therefore, the regulation, management and coordination of spectrum usage have become increasingly significant for spectrum accessing utilization [4]. The World Radiocommunication Conference (WRC) is the international body that decides on changes to the International Telecommunications Union (ITU) Radio Regulations, the treaty rules which govern the global use of a radio frequency spectrum throughout the world. The ITU is itself a United Nations (UN) body and the WRC occurs approximately every 4-5 years to review various aspects of these Radio Regulations. The WRC can be attended by any UN member nation, known as "administrations", and each has equal standing. According to the ITU, the world is spectrally divided into three regions for administrative purposes: Region I consists of Europe (including the former Soviet Union), Outer Mongolia, Africa, and the Middle East west of Iran; Region II includes the Americas and Greenland; and Region III covers Asia (excluding parts west of Iran and Outer Mongolia), Australia, and Oceania. Historically, these three regions have developed, more or less independently, their own frequency plans, which best suit local purposes [5]. Globally, the frequency spectrum bands are identified as either licensed bands or unlicensed (license exempt) band. Unlicensed bands are freely available for any experimental, provisional, or enterprise application. The three most popular unlicensed bands are 900 MHz, 2.4 GHz, and 5.7 GHz and called Industrial, Scientific, and Medical (ISM) band [6]. While, licensed bands are those that are currently "owned" by carriers that have paid for the use of these bands. Licensed bands are including the bands that are discussed in this thesis. ITU Radiocommunications sector (ITU-R) has started to become involved with the spectrum allocation for next generation mobile communication services since WRC 2007 (WRC-07). As a result of the work performed within ITU-R Working Party 8F (WP8F), the spectrum below 1 GHz (the Ultra High Frequency (UHF) band, 790–862 MHz) in Region 1 (Europe, Africa) and Region 3 (Asia/Oceania) and the band (3400–3600 MHz) have been recently identified at WRC-07 for the future development of International Mobile Telecommunications (IMT) systems.

2. Programming and Implementation Tools

The Propagation model will be analyzed and simulated by Matlab programming for a different environment, While a full data base of mobile users will be generated and simulated by ATDI software.

2.1 The Scientific Contribution

To find the percentage of error on map and validate the results using ICS Telecom Software . This project will give the first spark as a kick start for using correct software for wireless propagation detection.

2.2 Radio Propagation Model

A radio propagation model is an empirical mathematical formulation for the characterization of radio wave propagation as a function of frequency, distance and other characteristics. A single model is usually developed to predict the behaviour of propagation for every similar link under similar constraints. The essential aim of signal propagation studies is to formalize how the signal can propagate from one point to another. Only in such situation can a typical model predict the path loss effect on an area covered by a single or multi transmitter (s) [7]. It is found that ITU-R P.452-9 [9] is the most suitable propagation model for this study, because it can cover from 0.7 MHz to 30 GHz frequency range. The prediction of the line of sight LOS is a result of the signal after being exposed to the path and clutter loss model CEPT and ITU organizations have accepted a common formula for wireless transmission assessment at a microwave frequency level. This formula has incorporated the clutter attenuation as well as environmental effects, and is expressed as follows:

$$L(d) = 92.44 + 20\log d + 20\log f + A_h \quad (1)$$

where d (km) is the distance between interferer and victim FSS receiver, f is the carrier frequency in GHz and Ah is loss due to protection from local clutter (i.e clutter loss), and is given by:

$$A_h = 10.25\, e^{-d_k}\left[1 - \tanh\left[6\left(\frac{h}{h_a} - 0.625\right)\right]\right] - 0.33 \quad (2)$$

where dk (km) is the distance from nominal clutter point to the antenna, h is the antenna height (m) above local ground level and ha (m) is the nominal clutter height above local ground level. In [8], clutter losses are evaluated for different categories, such as trees, rural, suburban, urban and dense urban. Increasing antenna height up to the clutter height will result in a decrease in clutter loss, as shown in Table 2.1 and Figure 6.

***Table 1:** Nominal clutter heights and distances [9]*

Clutter Category	Clutter Height ha (m)	Nominal Distance dk (km)
Rural	4	0.1
Suburban	9	0.025
Urban	20	0.02
Dense urban	25	0.02

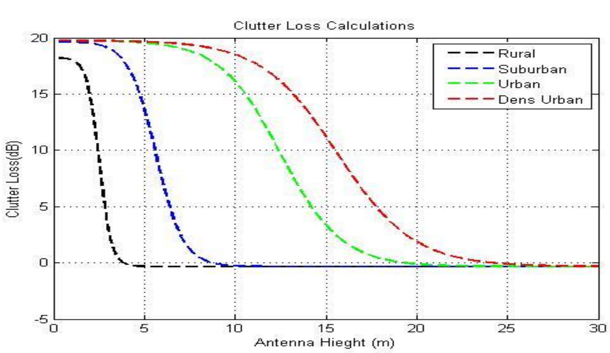

***Fig.6:** Clutter losses for rural, suburban, urban and dense urban areas.*

Table 1 reveals that the value of nominal distance is highest for rural and suburban areas, whereas for urban and dense urban areas the separation distance decreases in response to the clutter loss increment.

3. Required Protection Distance without Mitigation Techniques

Table 2 and 3 represent the GSM systems parameters based on a macro cell size for urban environment (Typically for Sulaimanyia City).

***Table 2.** GSM Base Station Parameters.*

Parameter	Value
Frequency	900 MHz
Bandwidth	200 KHz
Output power (Urban)	39 dBm/200KHz
Feeder loss	4dB
Antenna gain	20dBi
Antenna height	30m
Antenna down tilt	20
Antenna pattern	Rec. ITU-R F.1336-1

These parameters had been used in the simulation.

***Table 3** GSM Mobile Station Parameters.*

Parameter	Value to be used in this calculations
Frequency	900MHz
Bandwidth	200KHz
Output power	24dBm/50MHz
Antenna gain	0dBi
Antenna height	1.5m
Antenna pattern	Omni

4. The Implemented Toolset

The tools that used for implementation range from programming languages and data manipulation language to implementation tools, as shown in brief in section (1.7). The following are the programming and implementation tools in details: The implemented system includes Transmitter main subsystems that are integrated and worked together to Mobile user. These subsystems are:

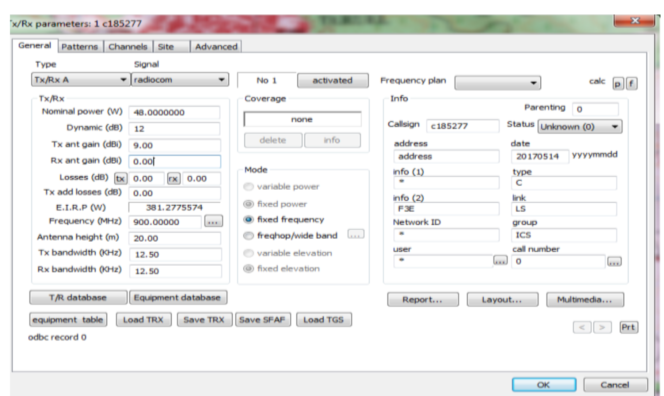

***Fig.7** Creating a Polygon, generate a Transmitter Change the subscribers parameters.*

5. THE INTERACTION WITH THE IMPLEMENTED SYSTEM

In order to test the implemented system. Figures below depict a typical interaction of user with the implemented system through waving the demonstration version.

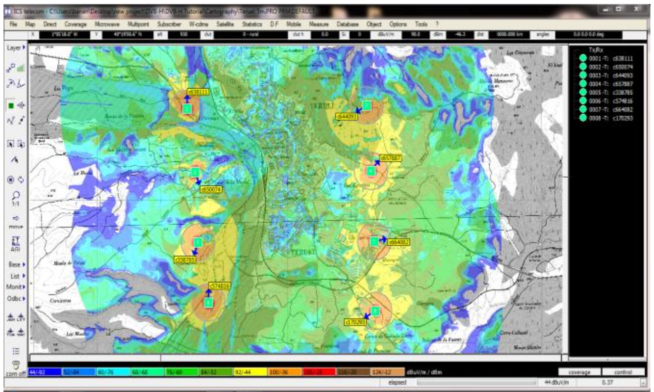

Fig.8. *Simulation results for 8 Towers , 15 meter height.*

Figure 9 shows that coverage area is not perfect, however, the green zone still week in many places on the map. Accordingly, we have repeated the simulation for 16 cells as in figure 10, to test the effect of increasing towers for the same geographic area. It is very important to note that the towers height is varied between 15 to 20 meters and 360 degrees is considered for each antenna. Figures 9, 10, and 11 shows the rest of the results:

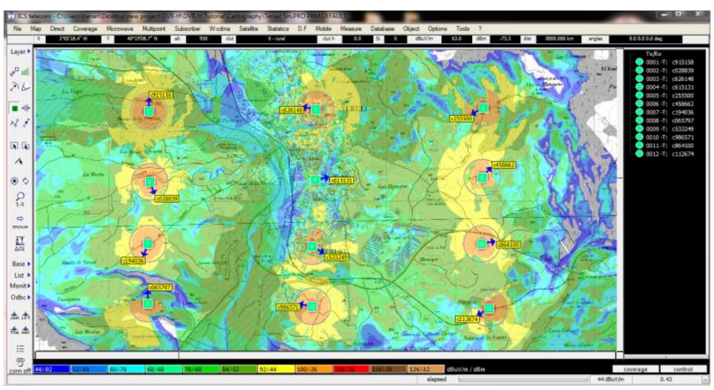

Fig.9. *Simulation results for 16 Towers , 15 meter height.*

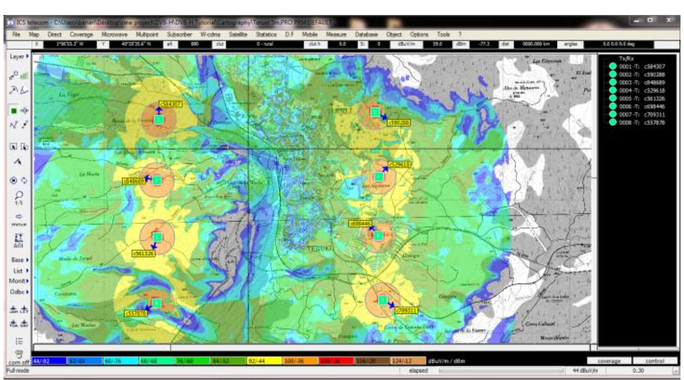

Fig.10. *Simulation results for 8 Towers , 20 meter height.*

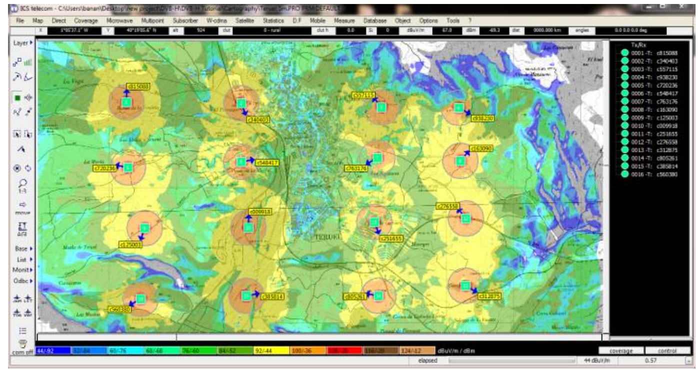

Fig. 11. *Simulation results for 16 Towers , 20 meter height.*

From the figures above, we can now estimate the best number of base stations deployment. And till now there is no perfect method to get the required number of towers unless we simulate the real scenario on the best map resolution. By doing though, we can reduce the deployment cost as well as reduce the harmfull effect of transmitted signals.

6. EMPIRICAL OUTCOMES

The problems that are encountered with the traditional methods concerning the network distribution had been solved up to 98% as demonstrated in the following result: Full GSM network had been design and simulated successfully with best BS distribution using ATDI for urban environment. It is obviously clear that choosing ATDI had reduced the cost of installing BS and gave the best signal distribution. ATDI Simulation Shows that different Base station heights can give different simulation results (higher is better). Accordingly, we can get good coverage with less cells number. Though, If we could cover all the area with less number of BS Will reduce Environment pollution and reduce the installation cost. A full simulation for GSM Wireless Modeling in Urban Environment has been done.

7. CONCLUSION

for this graduation research project (GRP), many points which are certain significance are drawn and concluded from this work, they are:

1. A full GSM Technology is not impossible to deploy in Sulaimanyia urban environment with the best simulation scenario, if we got the proper map.
2. Using the write software with proper maps will enable us to have best deployment and minimize the cost.
3. With the best network distribution we can have a less environment pollution; however, reducing the harmful wireless signal will happen in the best towers deployment.

The designed and implemented system presents many fruitful lines of continued graduation research, and opens the door to a range if future work, as listed in the following:

- Hardware deployment for fixed wireless network as a proposal for IMT-Advanced networks.
- Validate ATDI results with a practical implementation given by local ISP Company.

REFERENCES

[1]. 3GPP TR 25.942 V.7 (2007). 3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; Radio Frequency (RF) System Scenarios. 3rd Generation Partnership Project Organizational Partners.

[2]. Aegis (2007). Digital Dividend (Interference Analysis of Mobile WiMAX, DTT and DVB-H Systems). Ofcom. 1913/DD/R2/3.0.

[3]. Allgon, (1999). Antenna To Antenna Isolation Measurements. 3GPP TSG RAN WG4 Meeting No.8, TDOC 631/99.

[4]. Arapoglou, P.-D. M., Panagopoulos, A. D., Kanellopoulos, J. D. and Cottis, P. G. (2005). Intercell Radio Interference Studies in CDMA-Based LMDS Networks. IEEE Trans.on Antenna & Propagation. 53(8): 2471–2479.

[5]. Boer GD, Kupferschmidt C, Bederov D, and Kuchenbecker H.-P. (2003). Digital Audio Broadcasting in the FM Band Based on Continuous Phase Modulation. IEEE Trans. Broadcasting. 49(3): 293–303.

[6]. CEPT ERC Rep. 64 (1999). Frequency Sharing between UMTS and Existing Fixed Services. European Radiocommunications Committee within the European Conference of Postal and Telecommunications Administrations. Menton.

[7]. CEPT ERC Rep. 65 (1999). Adjacent Band Compatibility between UMTS and Other Fixed Services in the 2 GHz Band. European Radiocommunications Committee within the European Conference of Postal and Telecommunications Administrations. Helsinki.

[8]. CEPT ECC Rep. 100 (2007). Compatibility Studies in the Band 3400-3800 MHz between Broadband Wireless Access (BWA) Systems and Other Services. February. Electronic Communications Committee within the European Conference of Postal and Telecommunications Administrations. Bern.

[9]. CEPT ECC/REC/(01)05 (2001). List Of Parameters Of Digital Point-To-Point Fixed Radio Links Used For National Planning. Electronic Communications Committee/European Radiocommunications Committee within the European Conference of Postal and Telecommunications Administrations.

[10]. CEPT ERC Rep. 99 (2000). The Analysis of the Coexistence of Two FWA Cells in the 24.5 – 26.5 GHz and 27.5 – 29.5 GHz Bands. European Radiocommunications Committee within the European Conference of Postal and Telecommunications Administrations. Edinburgh.