



Comparative Analysis and Propagation Modeling of UMTS 900/2100 MHz Using Matlab and Signal Pro Simulations

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Abstract: UMTS (Universal Mobile Telecommunication System) network uses the band frequency 1920-1980 MHz or 2110-2170 MHz (Mega Hertz). However, Still remote areas where there are difficulties to provide UMTS services in a cost effective way, UMTS deployment in the 900 MHz band can facilitate the provision of the expected UMTS services to users in those areas. The main interest to propose the solution of UMTS in the 900 MHz band is the larger coverage compared to UMTS in the 2000 MHz band and larger penetration and in-depth coverage for indoor communication. UMTS 900 offers a considerably more cost effective solution for providing UMTS services in rural area with low population density. This paper proposed a UMTS 900/2100 co-existence overlay model for a cost effective solution of 3G (3rd Generation) UMTS deployment focusing on the Pakistan Telecom industry. Further, this paper gives some recommendations to the Pakistan Telecom Regulatory Authority and Telco operators on the basis of proposed model simulation results.

Keywords: UMTS, Analysis, Propagation, Modeling

1.

INTRODUCTION

The WCDMA (Wideband Code Division Multiple Access) benefits are combined by UMTS 900 at lower carrier frequency with better propagation advantage. UMTS 900 offers (less number of Node B's) CAPEX (Capital Expenditure) gains in rural morphologies and better building penetration in urban morphologies as compared to UMTS 2100. (Vanghi V. *et al*, 2007. Nicolae *et al*, 2008, S. Cordone *et al*, 2009) in 900 MHz band UMTS and GSM (Global System for Mobile Communication) is expected to co-exist. The coordinated or uncoordinated mode deployment can take place. The operation in coordinated requires one to one overlay of Node B's UMTS 900 with BTSs (Base Transceiver Stations) GSM 900. In this paper, the required parameters of UMTS 900/2100 have been studied in coordinated operation using lab RF planning tool, simulation, and virtual Drive test measurement.

2.

RELATED WORK

For cost effective solution of UMTS deployment there are many parameters that should be considered to design an economical solution. This paper has focused on some important features such as Cost, Path loss, Mobility Management, Coverage and QoS (Quality of Service), to get this services in UMTS 900 same as UMTS 2100 offered and proposed an UMTS 900/2100 Overlay co-existence model with existing GSM network, in which a multiband network operation

is considered with service level and appropriate propagation modeling selected with respect to the morphology standard as per UMTS profile and operating frequency range in network. In addition, it discusses the link profile study using virtual drive testing to compare the receiving values with them that are considered for this site according to service level and if any difference noticed between both values so recommend a revised process of site selection and interference analysis between these different networks. Then discuss the different site configuration co-existence scenarios with antenna sharing and separate antenna configuration using different techniques and their consequences.

3.

UMTS 900/2100 Co-EXISTENCE OVERLAY MODEL.

The UMTS 900/2100 Co-existence overlay model based on seven segments:

i) **Review the GSM network Coverage:** In this segment, before selection of site Review the existing GSM network coverage and frequency planning then select the GSM/UMTS 900/2100 co-existence site with respect to morphology, terrain and environmental characteristics and do frequency replanning if required.

ii) **Technical analysis of co-locating site:** In this

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segment model set the technical characteristics of the system and analyze the issue of co-locating the multi band antennas on the site particularly GSM/UMTS in 900 MHz and UMTS in 900/2100 MHz band.

iii) **Propagation model:** The new algorithm select antenna allocation, inter-system interference analysis and select the propagation model such as Okumora/Hata and Cost-231 Model with respect to operating range of frequency and service requirements of the system in the co-existence scenario of GSM and UMTS 900/2100 network.

iv) **UMTS WCDMA design:** After realizing the network service requirements in term of capacity, coverage, quality of service, mobility management and path loss, do the link budgeting or make link path profile for the GSM/UMTS 900/2100 co-existence network.

v) **Traffic density parameters:** After design the WCDMA system, select the traffic density parameters and load distribution with respect to network capability circuit switching/packet switching in operating networks e.g. GSM/UMTS 900/2100.

vi) **Co-existence network analysis:** After co-existence of GSM/UMTS 900/2100 network UMTS 900/2100 Co-existence overlay model analyze the combine network operations in terms of all considering parameters and services with respect to UE and Node B.

vii) **Drive Testing:** Using drive testing compares the values of considering parameters with desired values and site service related objectives if got far from design objective so review again technical issues and site configuration.

Simulation results discussed in section 4. UMTS 900/2100 Co-existence overlay model flow chart is given below.

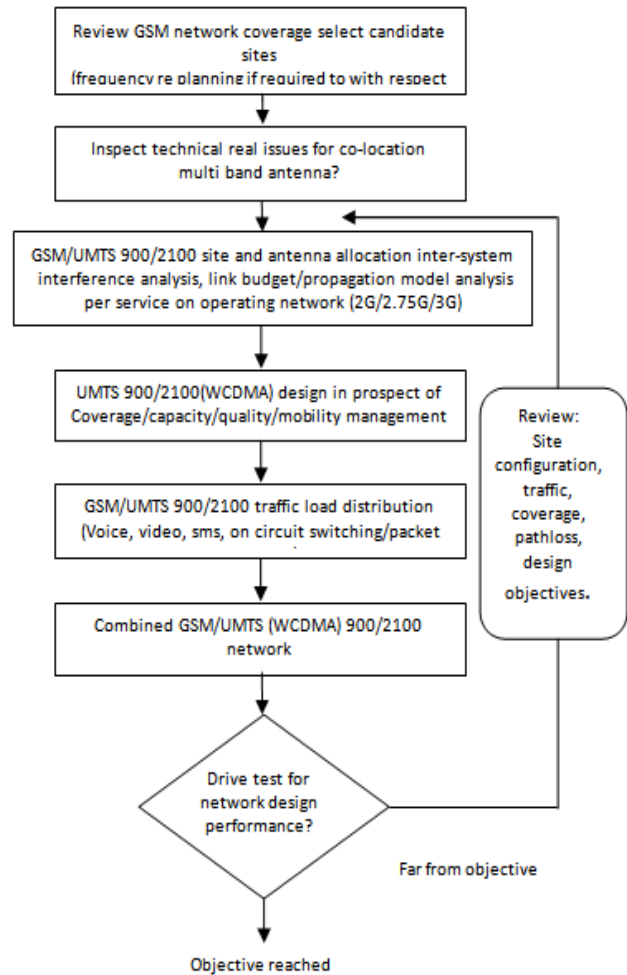


Fig:1 Flow chart of UMTS 900/2100 Co-existence model

4.

SIMULATION RESULTS

The Matlab and Signal Pro RF planning tool are used to conduct simulation for the Comparative Analysis and Propagation Modeling of UMTS 900/2100. The following Simulations results have been found.

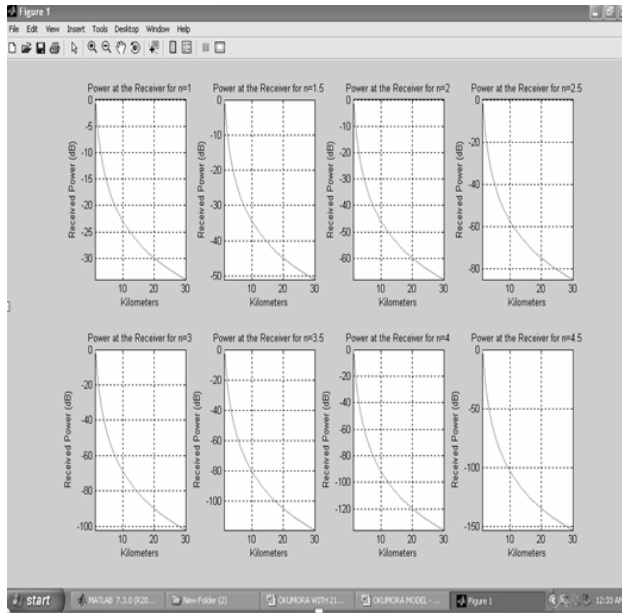


Fig: 2 Received Power versus Distance of Okumura model in 900 MHz.

We know that Okumura model is basically designed for the range of 150MHz to 1950MHz and mostly applied in GSM 900MHz propagation planning. In (Fig:2) it has been observed that the above Okumura model implemented with 900 MHz, range with respect to height 200m and the distance is 30 km. The above fig:2 simulation shows path loss $L_{50}=25.48$ db as increase the path loss factor “n” that is called power at the receiver with path loss factor the value of n is directly increases with respect to the distance.

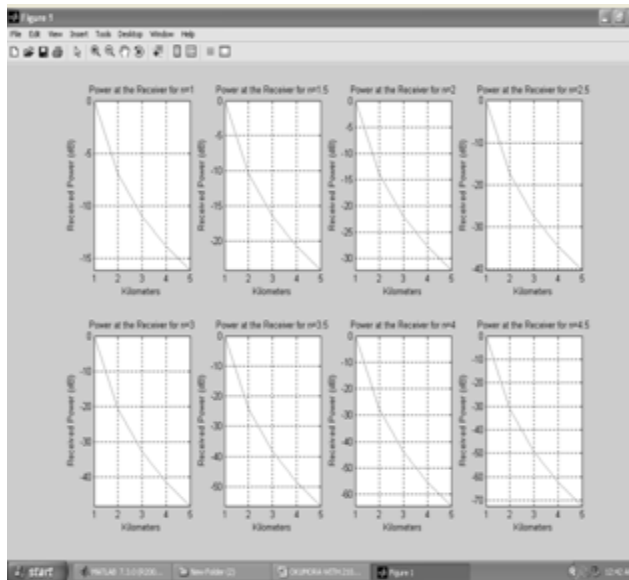


Fig: 3 Received Power versus Distance of Okumura model in 2100 MHz .

In (Fig:3) it has been observed that the above Okumura model implemented with 2100 MHz, range with respect to height 100m and the distance is 5 km. The above fig:3 simulation shows path loss $L_{50} = -13.4323$ db as increase the path loss factor “n” that is called power at the receiver with path loss factor the value of n is directly increase with respect to the distance. It is known that Okumura model is basically designed for the range of 150MHz to 1950MHz and mostly applied in GSM 900MHz propagation planning and in this (fig:3) we implemented this in 2100MHz that is not supported by Okumura model as results shows. However, it should use appropriate propagation model for 2100MHz like, HATTA Model /Cost-231 Extension of HATTA Model that support up to 2200MHz.

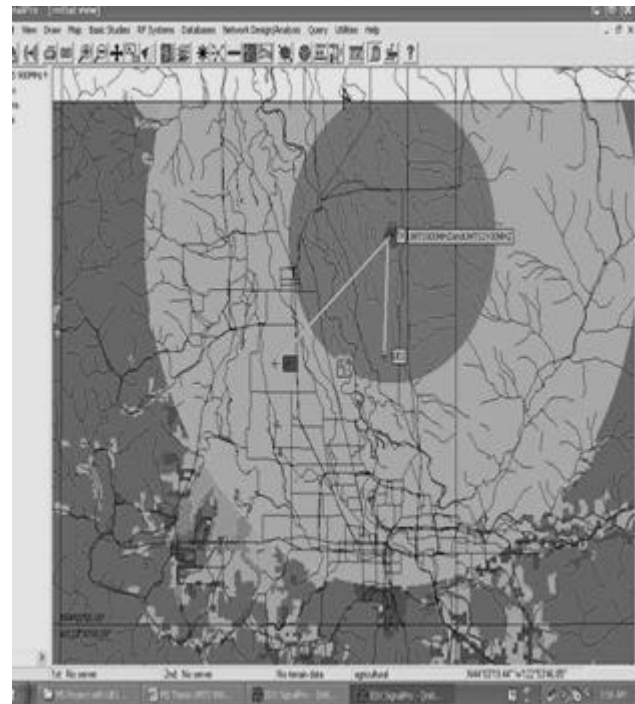


Fig:4 Simulation scenario one Node B connected with two UE with different frequency profile.

It has been observed in (fig: 4) that two UE connected with one Node B. UE1 is operated on 900MHz frequency with UMTS WCDMA system profile, on other hand UE2 is operated on 2100MHz frequency with UMTS WCDMA system profile. Both UE's is connected to one Node B in different sectors. Each sector is defined with respect to concerned frequency planning in UMTS WCDMA system profile. In above (fig: 4) there are two coverage beam circle, one shows coverage with white color and other one shows with black color. White color coverage shows the radius of UMTS 900MHz. Black color coverage shows the radius of UMTS 2100MHz.

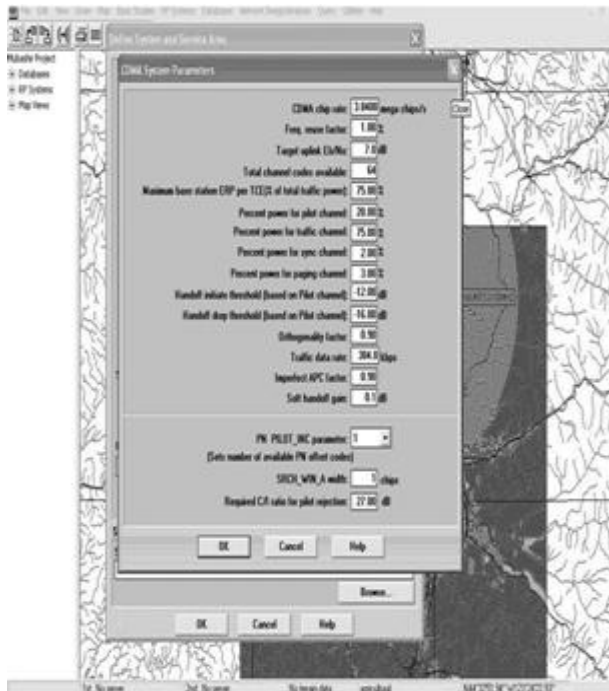


Fig: 5 WCDMA system parameters

It has been observed in (fig:5) that the basic UMTS WCDMA (FDD) system profile parameter is described. WCDMA is operated with 3.84 Mcps. It also shows that there is no requirement of reuse of the frequency in WCDMA system because it works on codes and it uses the universal reuse factor of 1 which means each cell could be used as same frequency as well.

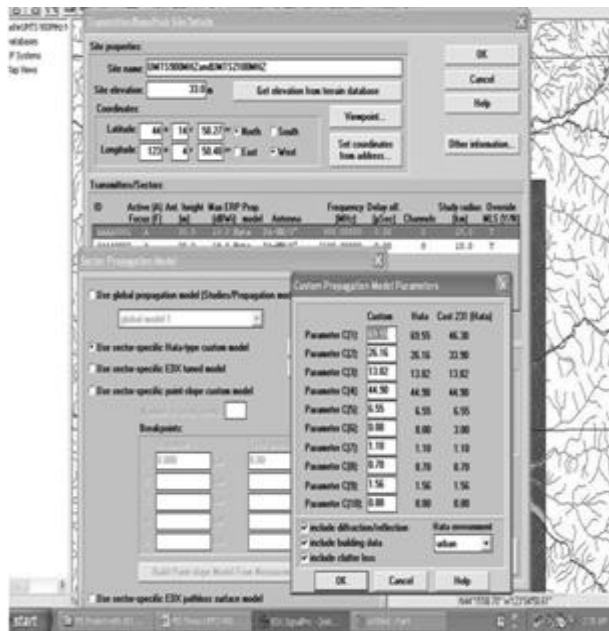


Fig: 6 UMTS 900MHz is modeled using Hatta Model

It has been observed in (fig:6) that the custom parameters of Hatta Model for UMTS 900MHz selected. It shows that Hatta model can support the frequency range of 150 MHz to 1920MHz.

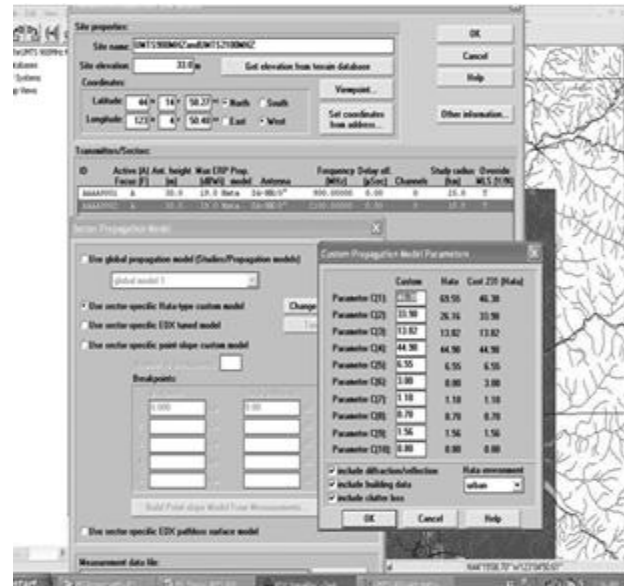


Fig: 7 UMTS 2100MHz is modeled using Cost-231(Hatta) Model

It has been observed in (fig:7) that the custom parameters of Cost-231 (Hatta) Model for UMTS 2100MHz has been selected. It shows that Cost-231 (Hatta) model is also called extension of Hatta model can support the frequency range of 150 MHz to 2200MHz.

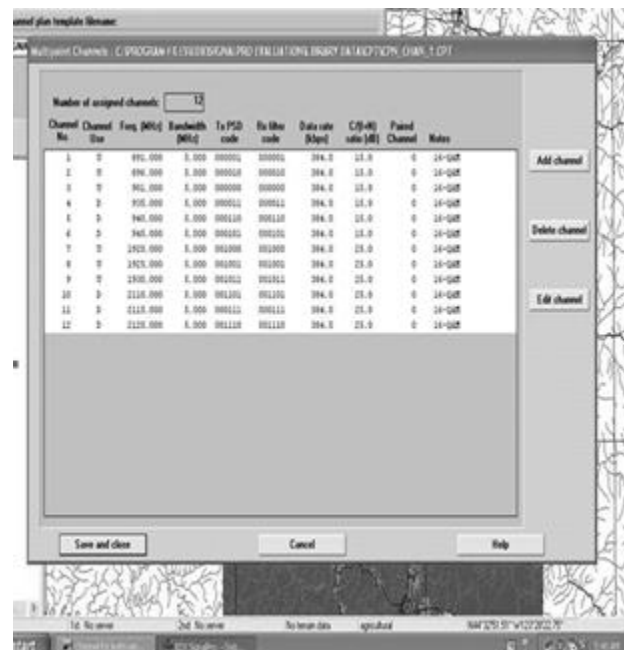


Fig: 8 Throughput achieved up to 384Kbps

It has been observed in (fig:8) that 6 channels are defined. 3 uplink channels in the range of UMTS WCDMA (FDD) 900MHz, also 3 Downlink channel in the range of UMTS WCDMA (FDD) 900MHz. on other hand 3 uplink channels in the range of UMTS WCDMA (FDD) 2100MHz, also 3 Downlink channel in the range of UMTS WCDMA (FDD) 2100MHz. it shows all channels are operated with 16-QAM modulation. It has been also observed that all channels are separated with the spacing of 5MHz. It has seen all channels support the throughput up to 384kbps.

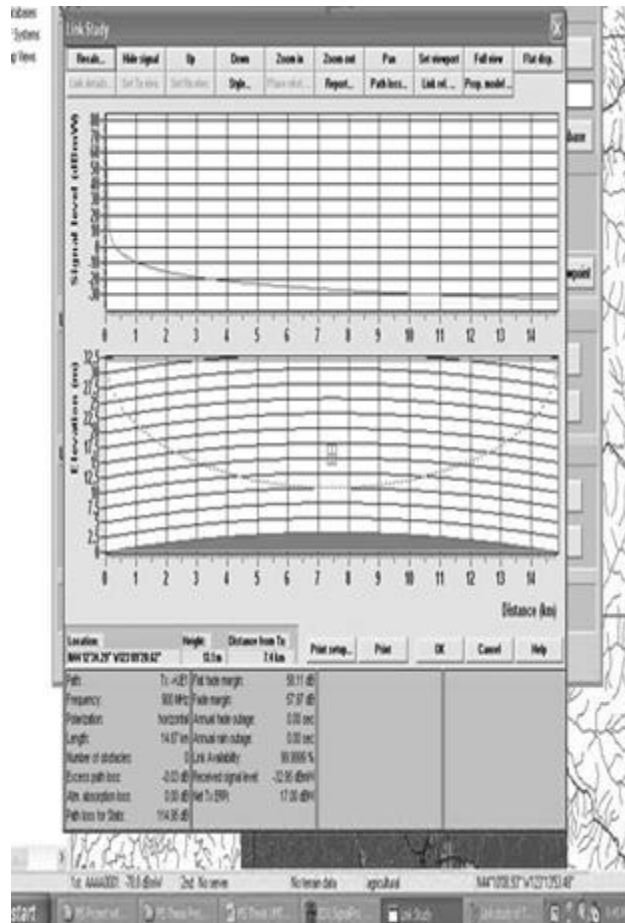


Fig: 9 Link Studies 1 of UE 1 with UMTS 900 MHz

It has been observed in (fig:9) that the link study has been done with UE 1 using UMTS 900 MHz frequencies. This fig:9 shows the basic parameters of UE 1 link study operated in UMTS WCDMA (FDD) 900MHz at the distance of almost 15KM. As we assumed the horizontal polarization in this UMTS WCDMA (FDD) 900MHz link study. As using HATA propagation model we received the maximum path loss of the study link is 114.95db.



Fig: 10 Link Studies 2 of UE 2 with UMTS 2100 MHz

It has been observed in (fig:10) that the link study has been done with UE 2 using UMTS WCDMA (FDD) 2100 MHz frequencies. It has been assumed the horizontal polarization in this UMTS WCDMA (FDD) 2100MHz link study. The all basic parameters of UE 2 link study operated in UMTS WCDMA (FDD) 2100MHz at the distance of almost 9KM. This fig:10 uses Cost-231 propagation Model we received the maximum path loss of the study link is 117.57db.

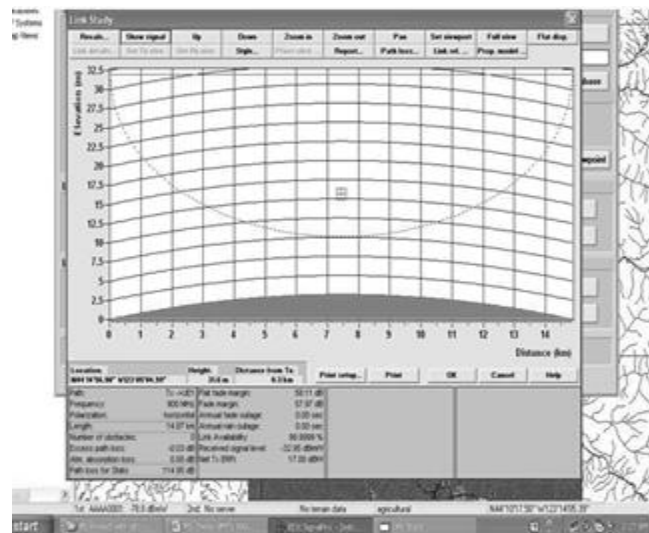


Fig: 11 UMTS network Link profile study of UE1 in 900 MHz.

It has been observed in (fig:11) that the link study of UE 1 that is operating on UMTS 900MHz shows the coverage path length of 14.87Km. It has been also observed that the path loss is 114.95db.

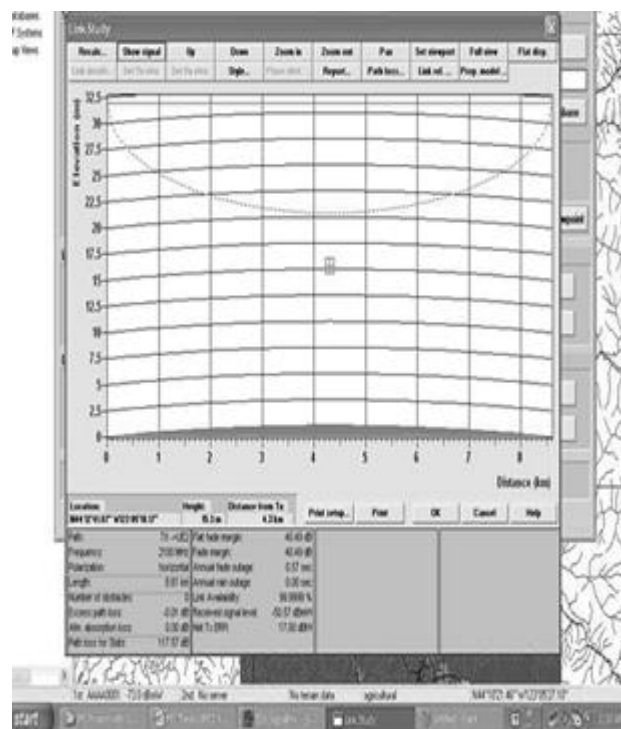


Fig: 11 UMTS network Link profile study of UE1 in 2100 MHz.

It has been observed in (fig:12) that the link study of UE 2 that is operating on UMTS 2100MHz shows the coverage path length of 8.81Km. And it has been also observed that the path loss is 117.57db.

5. CONCLUSION AND FUTURE WORK

This paper is based on the analysis of such important parameters that make a comparative analysis and performance evaluation of UMTS 900 Vs UMTS 2100 and UMTS 900/2100 Co-existence overlay model for cost effective solution of UMTS deployment. During comparative analysis of this research paper simulation results, it has been observed that UMTS 900 can provide many advantages as compared to UMTS 2100 in terms of wide cell radius coverage, that achieved up to almost 15km in rural areas and also capable to provide better indoor in-depth coverage for indoor communications. This research paper simulation results analysis also show that UMTS 900 can provide better quality of service because UMTS 900 require less numbers of sites to provide the maximum coverage as compared to UMTS 2100; so less number of sites means less number of handover ratio which increases the operating network performance quality.

An important parameter that has been investigated in this paper simulation is path loss; it has been observed that when system operate in high frequency profile, UMTS 2100 result in high path loss and in low frequency such as 900 achieved low path loss which indicate that while using UMTS in 900, there is need to add low fade margin in the link budgeting profile that is good for system performance. According to this paper comparative analysis and performance evaluation, it has been observed that if any Telco operator select the UMTS 900/2100 Co-existence overlay model in order to provide the good services in all areas according to morphology that Telco operator may be able to provide the 3G UMTS services in lower and existing band in 900MHz with all claimed services by UMTS 2100 but there is a condition that they should possess the operating experience of GSM network and should have a good existing deployed GSM network.

REFERENCES:

- Canjun R. M. Chen (2009) On the optimal antenna placement for DAS systems", Wireless Communications & Signal Processing, 2009. International Conference on, Nanjing, 1 – 3.
- Cordone S. (2009) Optimizing the Interoperation of 3G and 2G Networks at 900 MHz by UMTS Uplink Adoption, 10015-003,USA.
- Djukanovic, G., D.Ilic, (2012) Macrocell capacity and coverage planning for UMTS in GSM frequency band", Telecommunications (BIHTEL), IX International Symposium on, Sarajevo, 1 – 6.
- ECC PT1 (06)124, (2006) Analytical study of the coexistence between GSM-R and UMTS 900 based on the comparison of UMTS and GSM out-of-band emissions,. 105–111.
- ECC Report 82, (2006) Report on the compatibility study for UMTS being deployed within GSM900 and GSM1800 frequency bands, Electronic Communications Committee within the European Conference of Postal and Telecommunications Administrations (CEPT), ECC REPORT 82, 1-61.
- Erceg, V., L. J. Greenstein, (1999) An empirically based path loss model for wireless channels in suburban environments, Selected Areas in Communications, Journal IEEE, vol. 17, 1205–1211.
- Ferreira, L. M Kuipers, M Rodrigues, L. M . Correia, (2006) Characterization of Signal Penetration into Buildings for GSM and UMTS, International Conference on Wireless Communication Systems, IEEE, Valencia, 63 – 67.

Holma H., T. Ahonpaa. and E. Prieur (2007) UMTS900 Co-Existence with GSM900, ISSN 1550-2252 Vehicular Technology Conference, 2007. VTC2007-Spring. IEEE 65th, Dublin, 778 – 782

Marache F. and A. Char (2008) Downlink Impact of UMTS 900 on GSM 900 in Co-sited, Personal, Indoor and Mobile Radio Communications, PIMRC. 19th International Symposium on, IEEE, Cannes, 1 – 4.

Noblet, C.M.H., H.R. Owen, Saraiva, N. Wahid, (2001) Assessing the effects of GSM cell location re-use for UMTS network, 3G Mobile Communication Technologies, Second International Conference Publication No. 477, IEEE, London. Page(s): 82 - 86

Nicolae Cotanis, (2008) UMTS Overlay Deployment and integration at 900 MHz RFC 4226, IEEE.S. R. Saunders M. Hata, (2007) Empirical Formula for Propagation Loss in Land Mobile Radio Services”, *IEEE Transactions on Vehicular Technology*, vol. VT 29.

Vanghi V. Mustafa Saglam and Jiang Jindi (2007) Frequency Coordination between UMTS and GSM Systems at 900 MHz, Personal, Indoor and Mobile Radio Communications, PIMRC, 18th International Symposium, IEEE, Athens, 1-5

Nadir, Z. IAENG, Member, N. Elfadhil and F. Touati (2008) Pathloss Determination Using Okumura-Hata Model Proceedings of the World Congress on Engineering, London, U.K., Vol I.