Third Generation Wireless Modeling in Urban Environment
Kusay F. Al-Tabatabaie

Computer Science Dep., Cihan University – Sulaimanyia Campus, Iraq

Abstract—The global mobile communication is fast growing in industry. This paper recommends appropriate settings to evaluate the performance of wireless mobile system deploying third generation networks in an urban environment. To meet this aim, a case study of Sulaimanyia city is considered for this study by establishing suitable radio channel models. The work presents a statistical channel model, where fixed and nomadic analysis services are considered in the simulated radio coverage scenario. The cartographic dataset had been collected, and Matlab Software was used for showing the analysis and simulation results. Statistical channel models are derived that combine standard parameters such as separation distance, operating frequency and terminal height with more advanced and innovative parameters such as distance dependent shadowing and LOS probability.

Keywords—Mobile, 3G, Sulaimanyia City, propagation Model, ICS telecom cartography.

I. INTRODUCTION
The rapid revolution of wireless technologies in the past decade has led to the fast adoption of smart phones. Consumers are expecting every device they have to be connected to the network to record, transfer, view, or monitor data [1]. Therefore, as wireless technologies are evolving, so must radio planning methods. Many researchers worked to progress cellular solutions such as reducing transmit power, improving coverage, and provide high capacity connectivity [2-5]. The need to evaluate the performance of such systems in an urban environment is required for proper study to set radio channel model.

To determine the radio coverage is required to take into account the network type (Fixed, nomadic, mobile…) and target type (Major metropolitan areas or wireless complement connection for rural areas). This call radio signal path loss, which increases with increasing frequency. The radio frequency (RF) power of radio signals would be reduced when radio signals have travelled over a considerable distance. Therefore, in most cases, the systems with higher frequencies will not operate reliably over the distances required for the coverage areas with varied terrain characteristics [6]. For clear line of sight (LOS) propagation, the range between the transmitter and receiver is determined by the free space path loss (PL) equation [7], can be derived from the following expression (1)

$$PL = 20 \log_{10} \left( \frac{4\pi d}{\lambda} \right) \text{dB}$$

where $d$ and $\lambda$ are the range and wavelength in meters, respectively.

In Non-Line-of-Sight (NLOS) cases, the performance of higher frequencies is worse with reliable distances dropping even faster. Most paths are obstructed by objects and buildings. When penetrating obstacles, radio waves are decrease in amplitude. As the radio frequency increases, the rate of attenuation increases. Fig. 1 illustrates the effect of higher frequencies having higher attenuation on penetrating obstacles [8].

A radio beam can diffract when it hits the edge of an object. The angle of diffraction is higher as the frequency decreases. When a radio signal is reflected, some of the RF power is absorbed by the obstacle, attenuating the strength of the reflected signal. Fig. 2 show that higher frequencies lose more signal strength on reflection [9].
Conversely, high frequency is required to provide sufficient bandwidth. However, spectrum allocation widths are normally proportional to the frequency of the band and hence nominating the 3400-4200 MHz band for IMT-Advanced would allow the spectrum users to operate with more and wider channels [10]. The use of higher available capacity can also support much higher data rates than the lower spectrum. In addition, higher frequency can reduce the financial cost of licensing. It is important to notice that gain of antennas is a function to the frequency being received [11]. In free space propagation, clear and unobstructed line-of-sight (LOS) path is available and the first Fresnel zone is maintained between base station and terminal. Free space path loss can be obtained by using the logarithmic value of the ratio between the receiving and transmitting power as expressed in Equations 2, 3, 4 and 5. This simplified free space path loss model for unity antenna gain is based on [12]. Equations 3, 4 and 5 indicate that free space path loss is frequency dependent and it increases with distance. The increase of distance and frequency produce similar effect on the path loss.

\[ PL_{db} = 10\log_{10}\frac{Pr}{Pt} \]  
(2)

\[ PL_{db} = -147.56 + 20\log_{10}f_{hc} + 20\log_{10}d_{m} \]  
(3)

\[ PL_{db} = 32.44 + 20\log_{10}f_{MHz} + 20\log_{10}d_{km} \]  
(4)

\[ PL_{db} = 92.44 + 20\log_{10}f_{GHz} + 20\log_{10}d_{km} \]  
(5)

Where f is frequency, d is distance; Pr and Pt are the receiving and transmitting power in watts, respectively. Fig. 3 shows simulation for free space path loss for the frequencies 900 MHz, 2000 MHz, and 4000 MHz at different transmitter - receiver distances.

II. 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 a situation can a typical model predict the path loss effect on an area covered by a single or multi transmitter(s) [13].

It is found that ITU-R P.452-14 [14] 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:

\[ L(d) = 92.44 + 20\log_{10}d_{km} + 20\log_{10}f_{GHz} + A_h \]  
(6)

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

\[ A_h = 10.25e^{-d_k}\left[1 - \tanh\left(6\left(\frac{h}{h_a} - 0.625\right)\right)\right] \]  
(7)

where \( d_k \) (km) is the distance from nominal clutter point to the antenna, \( h \) is the antenna height (m) above local ground level and \( h_a \) (m) is the nominal clutter height above local ground level. In [14], 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 1 and Fig. 4.

<table>
<thead>
<tr>
<th>Clutter Category</th>
<th>Clutter Height ( h_a ) (m)</th>
<th>Nominal Distance ( dx ) (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>4</td>
<td>0.1</td>
</tr>
<tr>
<td>Suburban</td>
<td>9</td>
<td>0.025</td>
</tr>
<tr>
<td>Urban</td>
<td>20</td>
<td>0.02</td>
</tr>
<tr>
<td>Dense urban</td>
<td>25</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Where 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.

Fig. 4: Clutter losses for rural, suburban, urban and dense urban areas.

III. POINT-TO-MULTIPOINT (P-MP)
Similarly, a Point-to-Multipoint fixed service is one that involves a base station and a number of remote stations as shown in Fig. 5.

Fig. 5: Point-to-Multipoint FWA Service.

In a P-MP service, the base station sends a broadcast to the remote stations in the downstream direction and receives transmissions from the remote stations in the upstream direction. A sectored antenna [15, 16] is usually employed within P-MP service as in LMDS and Microwave Multipoint Distribution Service (MMDS) services.

IV. BROADCASTING SERVICES
The broadcasting service consists of sound, video and data broadcasting. Video broadcasting is a P-MP TV transmission for public reception, typically from a fixed emitter to fixed and portable receivers using the horizontal frequency (line repetition frequency). The channel bandwidth of the colour TV is 6 MHz in America and Japan, 7-8 MHz in Europe. Digital television is incompatible with analogue TV in terms of how the broadcasted information is represented as a signal. However, it must have RF spectrum compatibility. An important factor in defining the digital standard is to consider the channel bandwidth of existing analogue standards (or smaller bandwidth). Countries currently using Phase Alternation by Line (PAL) or Sequential Colour with Memory (SECAM) with an 8 MHz UHF bandwidth are likely to choose only a standard that can handle such channels Digital Video Broadcasting-Terrestrial (DVB-T). On the other hand, countries using National Television System Committee (NTSC) or PAL with 6 MHz bandwidth may choose any of the standards, while maintaining the bandwidth compatibility [17].

V. SIMULATION RESULTS AND ANALYSIS
In order to influence the choice of the propagation model, the urban radio planning had been performed for the cartographic dataset. However, the most important thing is the technology which applied to simulate the channel model in this urban environment. This technology depends on the technical characteristics and the type of applied engineering methodology such as fixed-type, mobile-type, using OFDM or not.

In this work, a wide range of wireless technologies for urban areas were considered, a combination from both of mature 3G and WLL technologies had been performed to sketch the quality of service (QoS) as shown in fig. 6.

Fig. 6: QoS to each sector in Sulaimanyia area

The overall (QoS) to each sector can be calculated according to:
- A service flow provisioning defined on a per mobile unit basis.
- The throughput available at each sector, calculated according to the OFDMA permutation.
and the number of data sub-carriers used, the UL/DL duration ratio, the modulation…

- A variation of the contention ratio according to the hour of the day.

The indoor propagation loss due to building absorption can be simulated by applying a diffusion coefficient per building type. To activate set allocation, radio-planner had been specify for each selected base station (BS), the active sets each BS in prediction tool, ICS telecom tool had been used as shown in fig. 7, where ICS Telecom is able to model both Inter channel Interference (ICI) and Inter Symbol Interference (ISI).

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Fig. 7: Coverage prediction for selected BS using ICS telecom cartography.

High Resolution data provides all building outline and heights. This type of simulation must be entirely deterministic in order to represent the canyon effect. The buildings here are physical obstacles to the standard signal propagation in ICS Telecom. Regarding the hand-over along a mobile path, if the radio planner is more particularly interested into a mobile path, a dedicated hand over analysis can be performed, in UL or in DL. Display as shown in fig. 8.

VI. CONCLUSION

The proposed channel propagation model had been presented using using ICS telecom cartography, where cartographic dataset type used to show streets, the buildings locations and heights outlined. For coverage calculations, the empirical or deterministic propagation model had been chosen using High Resolution datasets. This project novelty is to improves the accuracy of peer-to-peer channel power prediction in urban environments by using more advanced distance dependent shadowing, LOS probability. And provides solution to the problem of radio channel modelling in system level simulations that incorporate multi-hop/ad-hoc and fixed relay network elements in an urban environment in the 2-5 GHz range.

REFERENCES


