System Performance Analysis for 4G Mobile Wireless Communication System

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***Abstract*—In IEEE802.16m and LTE technologies, they all possess the advantages of high transmission rate and wide bandwidth. In information transmission between the mobile user and the base station it involves the propagation loss, the shadow fading loss due to building blocking and obstructions and the Doppler Effect due to the relative motion between the mobile user and the base station that will result in the signal fading at the receiver terminal. To maintain good service quality and system performance it needs to select a proper modulation format in the signal transmission. Every traffic service has its own requirement in its service quality.**

I. INTRODUCTION

IEEE802.16m and LTE each comes to the tasks for system engineers on how to select the proper system parameters in designing the new systems and how to meet the users in their service requirements. Based on the systems of IEEE 802.16m [1-2] and LTE [3] proposed from 802.16 and 3GPP we study the system performances when the number of users varies.

Each service has its own quality of service request. In this study it considers the path loss and fading between each base station and the mobile user to reflect the actual communication environment and then studies the system capacity by the selecting the proper modulation format through adaptive modulation and coding (AMC) scheme to performance system performance simulation.

II. CHANNEL MODEL

A. *Wireless Communication Channel Model*

When signals transmit through the channel they will be faded by many factors such as multipath effect due to the signals are reflected, scattered and diffracted by buildings, forest and terrains that received signals will be faded and the signals may not be correctly detected [4-8]. Furthermore Doppler Effect occurs when it has relative motion between the base station and the mobile station; Doppler Effect will make frequency modulation in the received signals that increase the uncertainties of the received signal qualities. Path loss model, fast fading model will be discussed in this paper and applied in the software development to have the simulation situation closes to the actual communication environment. The received power of the base station or the mobile user can be expressed in Equation (1):

$$P(dBm) = P_t + G_t + G_r - PL + F \qquad (1)$$

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When signals are transmitted their strengths will have different losses depending on the transmission distance and communication environments and the received signal strength is a random process; COST-231 Hata model [4] is usually applied in the description of average received signal strength.

COST-231 model is the empirical formula developed and compiled from many measurements of field trails as described in Equation (2), it is in principal applied in urban areas and for carrier frequency in 150 MHz and 1500 MHz.

$$PL(dB) = (44.9 - 6.55\log_{10}(h_{bs}))\log_{10}\left(\frac{d}{1000}\right) + 45.5 + (35.46 - 1.1h_{ms})\log_{10}(f) - 13.82\log_{10}(h_{bs}) + 0.7h_{ms} + \mathrm{C} \qquad (2)$$

The frequency band considered in Eq. (2) could not be applied directly to IEEE 802.16m and LTE bands for their operating frequencies, it has been modified into following equations (3) and (4) by Jakes and Reudlink, to extend the path loss model into 2–6 GHz frequency bands. Eq. (3) and Eq. (4) are applied to urban and suburban areas respectively, the frequency is in GHz.

$$PL_{urban}(dB) = (44.9 - 6.55\log_{10}(h_{bs}))\log_{10}(d) + 26.46 + 5.83\log_{10}(h_{bs}) + 26\log_{10}(f/2) \qquad (3)$$

$$PL_{suburban}(dB) = PL_{urban} - 2[1.5528 + \log_{10}(f)]^2 - 5.4 \qquad (4)$$

III. THE SOFTWARE SIMULATION

A. *The Interface of Simulation Software*

The simulation of base station performance is processed from GUI interface, the traffic service demand of each mobile user is generated first, their services are scheduled from the scheduler at the base station and signals are transmitted from properly selected modulation and coding schemes. The average traffic service quality and block error probability are then calculated, if the information needs to be retransmitted then the proper retransmission mechanism is selected and after all packets have been transmitted then the final system transmission rate can be calculated. The interface consists of six parts, as shown in Figure. 1, each part has its own parameters and functions.

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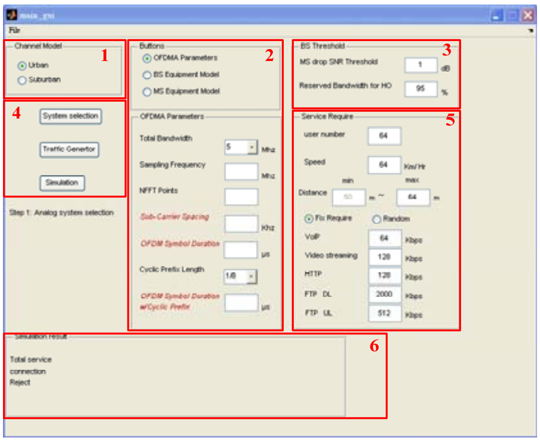

Figure 1. Main Interfaces

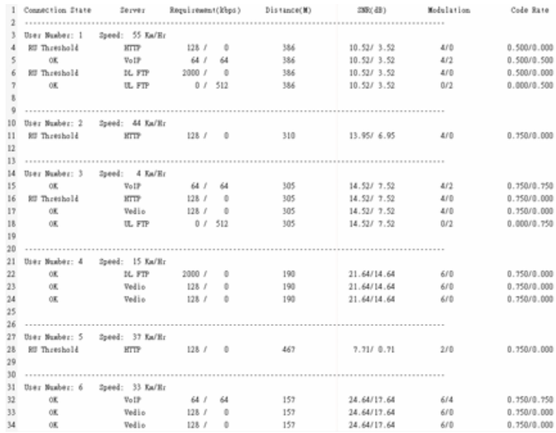

Figure 3. Output Report

B. Simulation Flows

As shown in Figure.2 is the simulation flow chart, it consists of three processes. First it needs to select IEEE 802.16m or LTE, different system will have different system parameters that are selected in the second process. Four traffic services as described in the above can be selected; it then selects the mobile velocity and the total number of users. After these parameters have been selected then after pushing the Traffic Generator button it will generate the resulting traffic models for a total of N users. In third process it simulates the base station total traffics that are based on the transmission distance between the base station and the mobile user, the path loss, the MCS scheme used in each user transmission and then it calculates the system block error rate (BER). The outputs will display each user location, user's modulation format, SNR value etc.

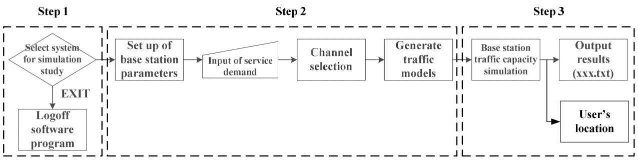

Figure 2. Simulation Flow Chart

Simulation parameters are listed in Table I, each user can have at most of four types of service, and service traffic capacity is normal distributed and their output results are shown in Figure. 3.

TABLE I.
SIMULATION PARAMETER

Parameter	Value
Sampling Frequency	5.6 MHz
NFFT Points	512
GI	1/8
MIMO	2X2
Channel Estimation	MMSE
User Number	30

IV. CONCLUSION

These simulations results were obtained under the restrictions that the service quality is guaranteed above certain level and the limitations in the allocation of certain system parameters such as the allowable bandwidth allocated for handoff, the limit in the base station downlink SNR and the guaranteed service quality etc. Through the study of the signal fading characteristics when the signal was transmitted and passed through the channel and when many users were considered in the system then the system performance could be improved or optimized when proper MCS mechanism was selected for each user.

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