Performance Evaluation of WINNER-II Channel Model for Long Term Evolution (LTE)

M.S. Hossain, R. Adhikary, N Yesmin

Abstract— The Third Generation Partnership Program's Long-term Evolution (3GPP LTE) group is developing a new standard for mobile broad-band access that will meet the throughput and coverage requirements beyond third generation cellular technology. The key goals for this evolution are increased data rate, improved spectrum efficiency, improved coverage. To evaluate and ensure the overall performance of LTE technology proper channel model which is WINNER II have been actively studied and considered in the standardization process of next-generation mobile broadband communication system.. This paper focuses the WINNER II channel modeling & evaluates the performance of this model in LTE network. As an outcome, the simulation results from the simulator show that WINNER II technologies can effectively perform better.

Keywords— LTE, Channel Model, WINNER-II, Throughput, BLER, Wireless Communications, SNR.

1 Introduction

The goal of this paper is to compare between different types of channel modeling e.g. WINNER II, PadA, PadB, VehA, VehB for LTE system in different scenarios and suggest which one of the channel model is performing better for LTE platform.

This paper also focuses on evaluating the performance of Winner II channel model in an LTE network. The performance is evaluated by analyzing the block Error Rate (BLER) and Throughputs for a certain range of SNRs (Signal to Noise Ratio). For the simplicity of the simulation environment a number of maximum two scenarios have been considered as well as a simulator is also designed which is LTE link level simulator.

2 LTE (Long Term Evolution)

Long Term Evolution (LTE) based on the radio access technology, is a 3G (third generation) wireless system's partnership project.

LTE is taking momentum and continuing to grow at an accelerated pace. However, it is necessary to further develop the future demands for mobile broadband services through higher data rates, shorter delays, and even greater capacity. In parallel to these activities related to the evolution of current 3G wireless technologies, there is also an increased research effort on future radio access, referred to as fourth generation (4G) radio access.

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Such future radio access is anticipated to take the performance and service provisioning of wireless systems a step further, providing data rates up to 100 Mbps with wide area coverage and up to 1 Gbps with local area coverage, fulfilling the requirements for Beyond IMT-2000 systems[2][3]

To meet the challenges of major enhancements to LTE Advanced which will be introduced in release 10, 3GPP has initiated the study item on LTE-A, aiming at achieving additional substantial leaps in terms of service provisioning and cost reduction[4][5]

3 LTE Transmission Scheme

For the performance study of LTE link level we first need to know LTE transmission scheme. The core of the LTE down link radio transmission is the Orthogonal Frequency Division Multiplexing (OFDM) with data being transmitted on a large number of parallel narrow band sub carriers. This is an attractive property as it simplifies the receiver base band processing with a reduced terminal cost and power consumption as consequences. This is especially important taking into account the wide transmission bandwidths of LTE .

Single Carrier FDMA, is used for the LTE up link. SC-FDMA(Single Carrier Frequency Division Multiplexing) has similar performance and essentially the same overall structure as those of an OFDMA system. One prominent advantage of SCFDMA over OFDMA is that the SCFDMA signal has lower peak to average power ratio (PAPR). In the uplink communications low PAPR greatly benefits the User Equipment (UE) in terms of transmit power efficiency [2].

4 WINNER II Channel Model

In the very beginning no simulation model was found for WINNER II model. To solve this problem math lab code for winner II model has been collected from winner website and then implemented in the simulator to generate simulation model for WINNER II. The scenarios have been simulated on MATLAB completely. No actual devices or instruments are involved in this evaluation. So the outcome results are more theoretical rather than practical. For simulation free and open sourced channel models are required. But except WINNER II channel model, other models are closed sourced and restricted by the developer(s). So this paper utilizes only the free and open sourced WINNER II channel model.

WINNER II generic model is a system level model, which can describe arbitrary number of propagation environment realizations for single or multiple radio links for all the defined scenarios for desired antenna configurations, with one mathematical framework by different parameter sets. Generic model is a stochastic model with two (or three) levels of randomness. At first, large scale (LS) parameters like shadow fading, delay and angular spreads are drawn randomly from tabulated distribution functions. Next, the small scale parameters like delays, powers and directions arrival and departure are drawn randomly according to tabulated distribution functions and random LS parameters (second moments). At his stage geometric setup is fixed and only free variables are the random initial phases of the scatterers. By picking (randomly) different initial phases, an unlimited number of different realizations of the model can be generated. When also the initial phases are fixed, the model is fully deterministic.

5 SIMULATOR IMPLEMENTATION

The WINNER Channel Modeling Process is divided into three phases. The first phase starts from definition of propagation scenarios, which means selection of environments to be measured, antenna heights, mobility, and other general requirements. Generic model is needed to know what parameters have to be measured. Planning of We have used the LTE Link Level Simulator v1.7r1089 from the Vienna University of Technology, Austria [6]. Link level simulation enables us to emulate all the features of transmission between the base station and the terminal. This simulator is a MATLAB based downlink physical layer simulator for LTE. It can carry out single downlink, single cell multi user and multi cell simulations. Figure 7.4 depicts an overview of different possible simulation scenarios in the LTE simulator. But in this thesis the focus is on single user single input single output & multi user multi input multi output.

6 COMPARISON

Here Winner-II channel model is compared with other channel models for different scenarios. Winner-II and other channel models were simulated in MATLAB for different scenarios and the results are compared in terms of BLER and Throughput. The graphs and results are discussed bellow.

6.1 Comparison (BLER Vs SNR) & (Throughput Vs SNR) for urban macro cell

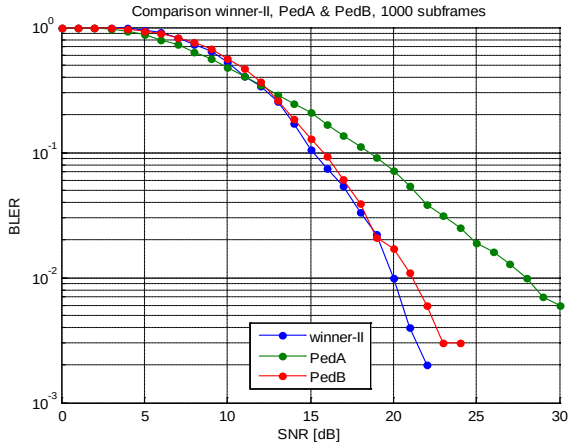

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Figure 1: Comparison (BLER Vs SNR) for Urban macro-cell.

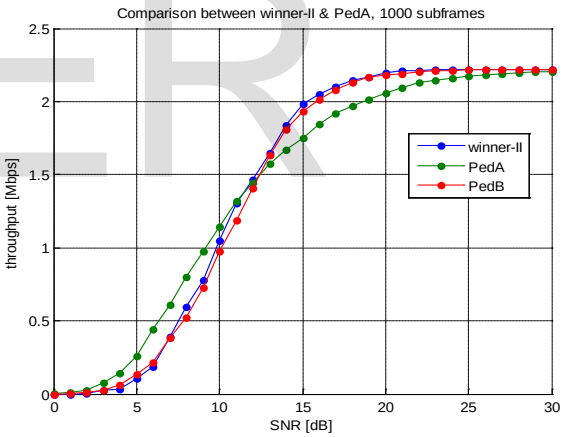

Figure 2: Comparison (Throughput Vs SNR) for Urban macro-cell.

For the higher SNR performance of Winner-II channel model is a better then urban macro cell channel model in terms BLER and Throughput.

6.2 Comparison (BLER Vs SNR) & (Throughput Vs SNR) for Moving networks

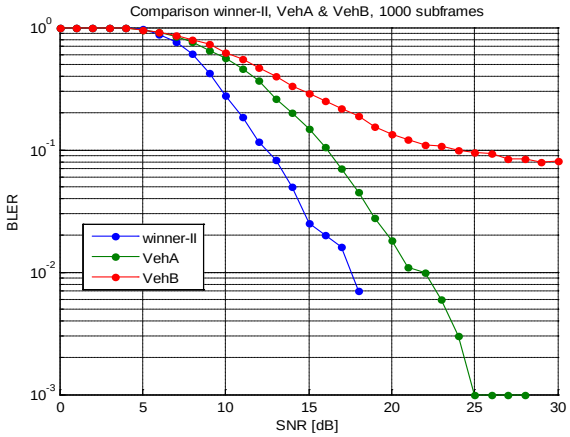

Figure 3: Comparison (BLER Vs SNR) for Moving networks.

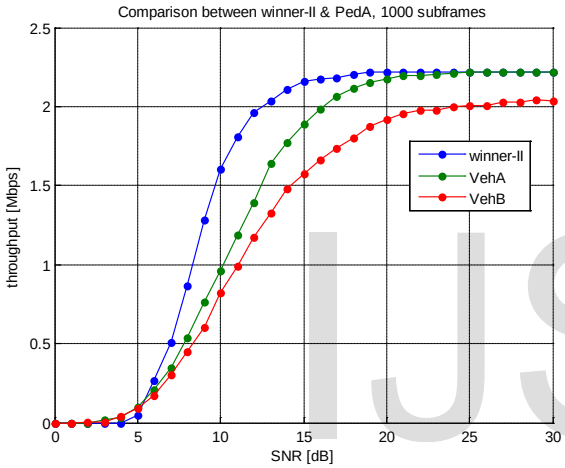

Figure 4: Comparison (Throughput Vs SNR) for Moving networks.

In case of moving network Winner-II is performing better than the other channel model like VehA and VehB. For the moving network BLER and Throughput performance is much better then VehA and VehB channel models.

6.3 Bandwidth/Frequency dependence

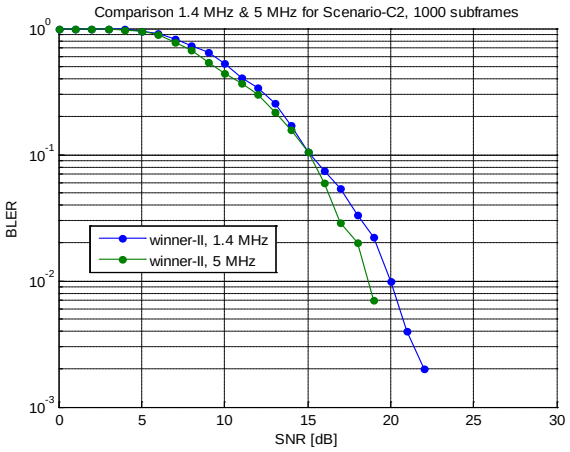

Figure 5: Bandwidth dependence (BLER Vs SNR) for Urban micro cell.

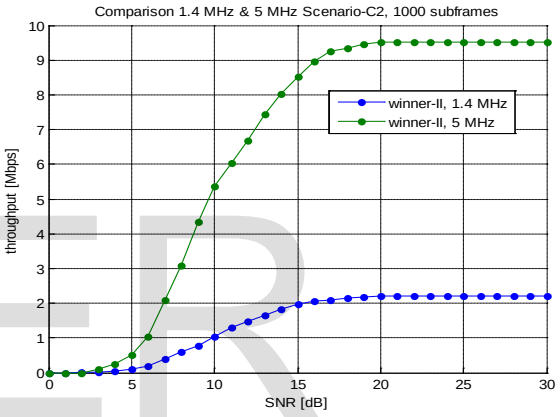

Figure 6: Bandwidth dependence (Throughput Vs SNR) for Urban

With the increase of BW the BLER is lower down in case of Winner-II channel model and with the increase of frequency at higher SNR Throughput is getting better in case of Winner-II channel model.

6.4 For Moving networks

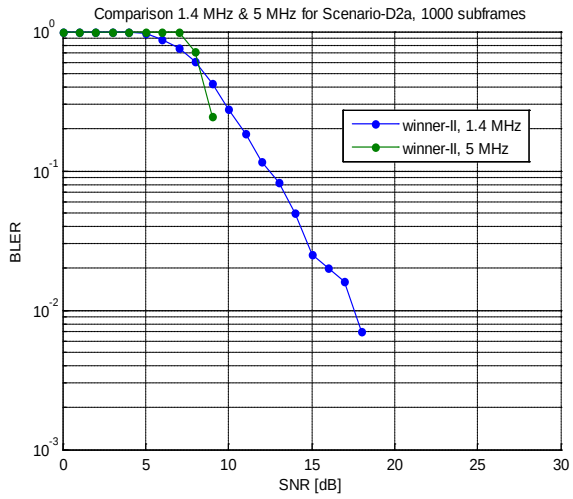

Figure 7: Bandwidth dependence (BLER Vs SNR) for Moving network..

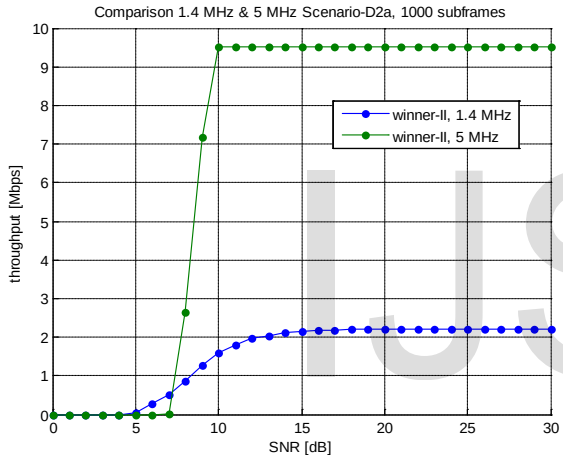

Figure 8: Bandwidth dependence (Throughput Vs SNR) for moving network.

Winner-II channel model is performing better at high frequency for the moving network in term of BLER.. Throughput performance is also increases with the increase of frequency for the moving network.

7 OUTCOME

The simulation results have showed that, for Urban macro-cell and moving networks scenario, Winner II has performed well because of its low BLER and high throughout response for high SNR. It has showed same result for increasing bandwidth and performed well at high frequency than other models. Analysis has showed that Winner II Channel Model performed better than (PedPedB) & (VehA, VehB)

8 CONCLUSION

The main idea of this study is to compare the advantages of WINNER II channel model with the other existing channel models into a current LTE model to show which one is better for improved and better channel modeling and to extend system support in the near future. The simulation results have showed that, Winner II has performed better than the because of its low BLER and high throughout response for high SNR. It has showed same result for increasing bandwidth and performed well at high frequency than other models. Analysis has showed that Winner II Channel Model performed better than other channel

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REFERENCE

[1] "An Introduction to LTE". 3GPP LTE Encyclopedia. Retrieved December 3, 2010.

[2] S. Parkvall et al.; Evolving 3G Mobile Systems: Broadband and Broadcast Services in WCDMA, IEEE Communications Magazine, February 2006.

[3] 3GPP, RP-040461; Proposed Study Item on Evolved UTRA and UTRAN ;www.3gpp.org.

[4] D. Astely et al.; A Future-Radio-Access Framework; Journal on Selected Areas in Communications, Special Issue on 4G Wireless Systems.

[5] E. Mino Diaz, et al.; The WINNER project: Research for new Radio Interfaces for better Mobile Services; IEICE Transactions, Japan, Vol. E87-A, No. 10, October 2004.

[6] C. Mehlfuhrer, M. Wrulich, J.C Ikuno, D. Bosanska, and M. Rupp, "LTE Link Level Simulator Documentation", August 2009.

[7] A. Pokhariyal, T. E. Kolding, P. E. Mogensen; "Performance Of Downlink Frequency Domain Packet Scheduling For The Utran Long Term Evolution"; The 17th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, 2006.

[8] F. Frederiksen, T.E. Kolding; "Performance and modeling of WCDMA/HSDPA transmission/H-ARQ schemes"; Vehicular Technology Conference, 2002. Proceedings. VTC 2002-Fall. 2002 IEEE 56th..