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LTE Physical Layer DL Simulator & PSS Detection Algorithm Evaluation Using the LTE DL Simulator

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Abstract:TheLTE PHY simulator will be able to implement all the processes of physical layer in less time and more accuracy.The simulator presented here can be done for any bandwidth, channel models and modulation schemes. This paper presents synchronizing algorithm withdownsampledsynchronizing signals and shows the results on several channels.

Keywords: Low cost, low power, matched filter, primary synchronization signal (PSS).

I. Introduction:

The explosive growth of cell phone users and the increasing demand for broadband wireless access has led to the development of long term evolution (LTE) to replace the wideband code division multiple access (WCDMA)-based air interface by the 3rd Generation Partnership Project (3GPP). Several minimum requirements of LTE include packet datasupport with peak data rates of 300 Mbps in the downlink and 75 Mbps in the uplink.
Carrier aggregation, MIMO (Multi Input and Multi output), CoMP (Coordinated multipoint Transmission and reception), Self-Organizing Network (SON) are the salient features of LTE.
The physical layer deals with bit-level transmission between different devices connecting to the physical medium for synchronized communication.

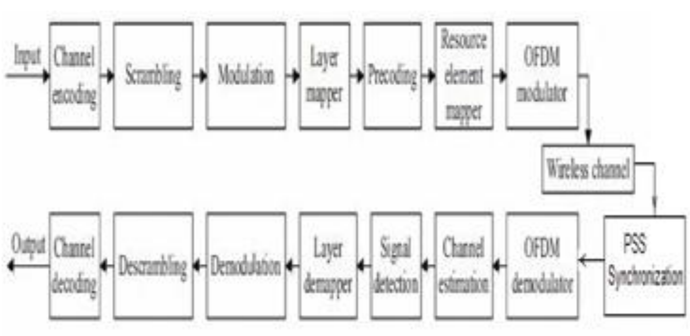

Fig. 1: 3GPP LTE downlink system model

Synchronization sequence is more important because its detection affects not only search time but also performance of demodulation. The 3GPP working group undertakes plenty of rigorous evaluation of different kinds of sequence to enhance the performance of search time. Consequently, it was decided to adopt Zadoff-Chu (ZC) sequences as the downlink primary synchronization signal (PSS) and the uplink random access preamble. The ZC sequences are a group of general-chirp-like sequences with good correlation properties. Currently used matched filters are computation- intensive since they require a large number of constant complex multiplications.In LTE system, in order to access the network, User Equipment(UE) should detect the primary synchronization signal (PSS) and secondary synchronization signal (SSS) in downlink (DL) signal from the surrounding base stations (BS).In FDD, PSS is mapped to the last OFDM symbol in slots 0 and 10. The PSS is mapped to the third OFDM symbol in sub frames 1 and 6 in TDD.
PSS is ZC(zadoff Chu) sequence which is 62 complex symbols.

$$d(n) = \begin{cases} e^{-\frac{j\pi u n(n+1)}{63}} & \text{for } n= 0, 1,....30 \\ e^{-\frac{j\pi u(n+2)(n+1)}{63}} & \text{for } n= 31, 32,.....61 \end{cases}$$

For NID=0,1,2 u= 25,29,34.
When these codes are used as a synchronization code, the correlation between the ideal sequence and a received sequence is greatest when the lag is zero. The ZC sequence is chosen for its good periodic autocorrelation and cross-correlation properties.In particular, these sequences have a low frequency offset sensitivity. Thus, it is easy to detect PSS during the initial synchronization because the ZC sequence has the flat frequency domain autocorrelation property and the low frequency offset sensitivity.

II. LTE DL PHY Simulator And PSS Detection Evaluation Using Simulator:

LTE Downlink Physical Layer simulator, which comprises of Transmitter, Channel model and Receiver Sections has been developed. The simulator supports export and import configuration to reproduce the configuration of interest quickly.A PSS detection algorithm has been tested using the LTE DL simulator. LTE Simulator enabled simulation of the algorithm in a close to real-world scenario with various channel models.

A. LTE DL PHY SIMULATOR:

Simulation is the optimal means to evaluate the booming researches on how to enhance the end-to-end service reliability of data over LTE network. The physical layer deals with bit-level transmission. Coding, modulation, layer mapping, resource mapping, synchronization, channel estimation, equalizing, etc. are the mechanisms to be done in physical layer. In order to implement the above mentioned process in hardware it becomes complex, costly and we may come across device hardware problems and also the practical implementation of the process takes huge time. Therefore we proceed to PHY simulator where we will be able to study the problem at different levels of abstraction in less time. The simulator presented here can be done for any amount of bandwidth over any channel models whether it is pedestrian, vehicular or urban with any modulation schemes, duplex modes, etc. LTE simulator is compatible with experimental studies on most aspects. LTE SIMULATOR is simple to use by providing a configuration files to set up the LTE channel fading scenarios.

Table: Parameters used in different configurations

Configurations	Parameters
EnodeB	Bandwidth
	Cyclic Prefix
	Duplex Mode
	Cell ID
	Control Format Indicator
	Antenna Ports
Downlink	TX Scheme
	Modulation
	Number of Layers
Channel	MIMO Correlation
	Channel model
	Doppler frequency
	Fading time
	Signal to Noise ratio

LTE SIMULATOR is simple to use by providing a configuration files to set up the LTE channel fading scenarios. With MATLAB R2014 we have predefined functions, with them we can compare and test our customized modules.

We see the LTE Downlink Physical layer simulator as mentioned below.

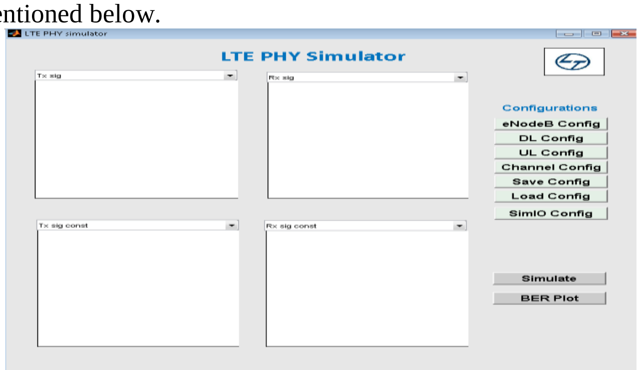

Fig2: LTE Downlink physical layer simulator

B. DETECTION METHOD :

The main function of PSS is to detect the boundary of a frame where non-coherent detection method has to be used at the receiver since there is no known reference information initially. Matched filter is a basic non-coherent detection method that can be used to detect PSS efficiently.The ZC sequence is mapped to the subcarriers around DC and transformed to time domain by n size IDFT. The n value is obtained from the lteOFDMModulate ()function which converts the frequency domain signal to time domain signal. To detect this signal at the receiver, the correlation with the timedomainsignal of the ZC sequence is calculated.

The correlation is given by

$$C_u(m) = (W^H d\ (n)\ )^H y$$

Where y is received signal, w is DFT matrix, d (n) is the PSS signal.

The index value of the peak gives the location of the PSS in the time domain signal.

OFFSET FUNCTION:

This function performs synchronization using the reference signals defined in the LTE standard, returning the measured timing offset from the start of the input waveform to the start of the first frame in offset. The offset is computed by extracting the timing of the peak of the correlation between received waveform and down sampled internally generated time-domain reference waveforms containing PSS and SSS signals. The correlation is performed separately for each antenna and the antenna with the earliest correlation peak is used to finally compute offset.

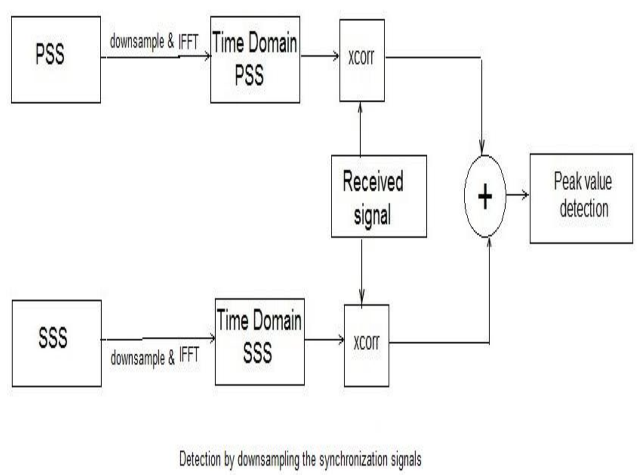

Fig3: Modified synchronizing method

The offset value is given by

Offset = modulus (peak value location -1 + cplength/2,framelength)- cplength/2.

III. EXPERIMENTAL RESULTS :

A. SIMULATOR RESULTS:

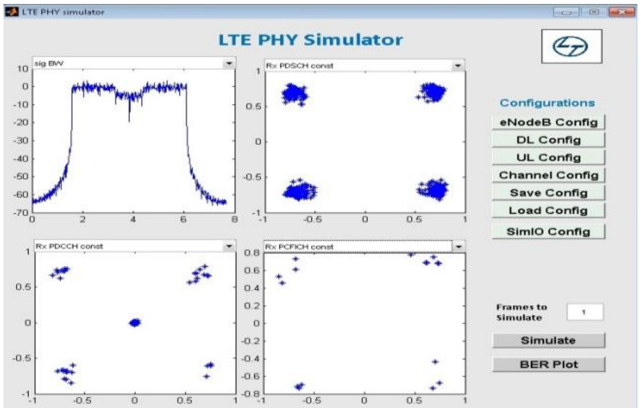

Fig4: LTE DL PHY simulator with default configurations which are 5MHZ bandwidth, FDD duplex mode, Normal cyclic prefix, cell ID of 10, Single antenna port, QPSK modulation scheme with vehicular channel model at SNR of 40.

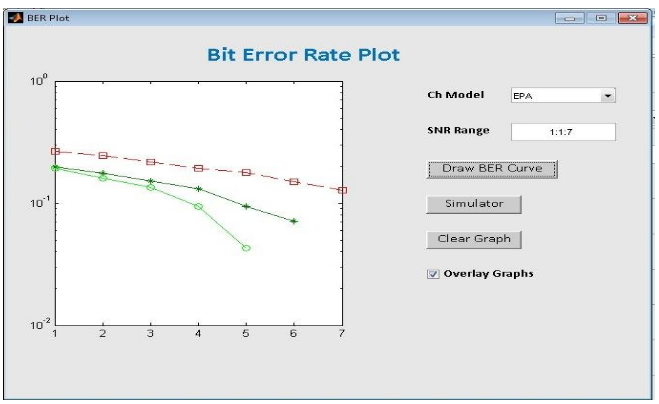

Fig5: BER plot under various channel models simultaneously

B. DETECTION METHOD RESULTS:

PEDESTRIAN CHANNEL MODEL RESULTS:

The accuracy of the synchronizing point at each SNR for different channel conditions is as shown below.

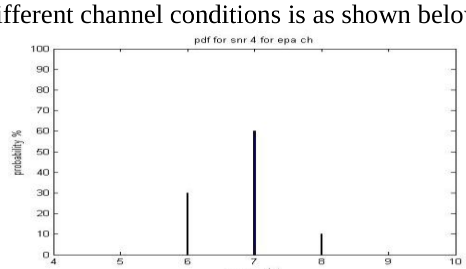

Fig6: probability of the occurrence of the synchronizing point at SNR 4.

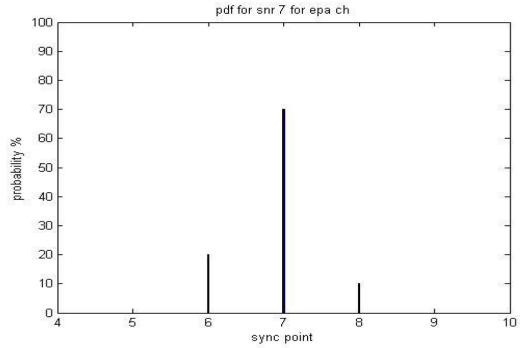

Fig7: probability of the occurrence of the synchronizing point at SNR 7.

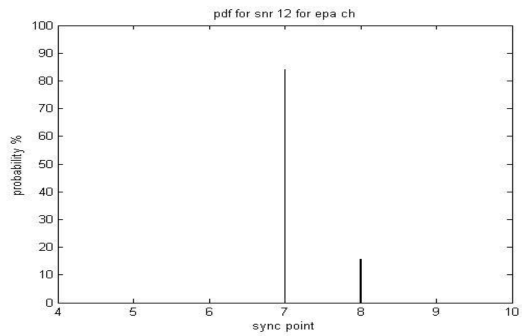

Fig8: probability of the occurrence of the synchronizing point at SNR 12.

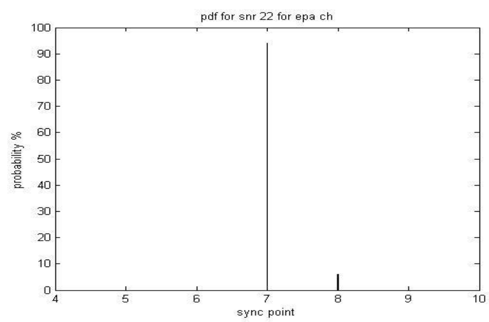

Fig9: probability of the occurrence of the synchronizing point at SNR 22.

VEHICULAR CHANNEL MODEL RESULTS:

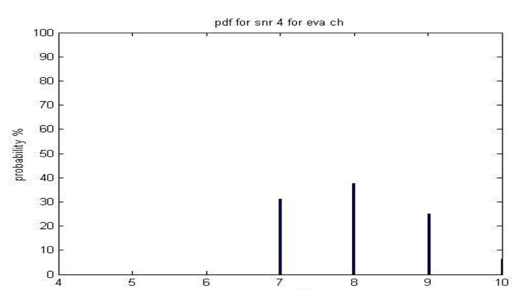

Fig10: probability of the occurrence of the synchronizing point at SNR 4

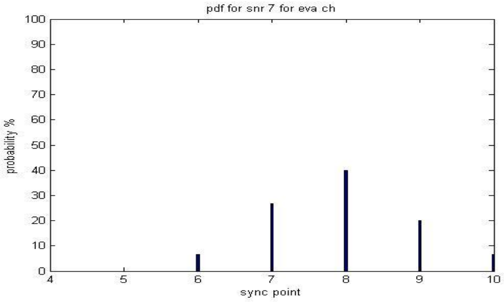

Fig11: probability of the occurrence of the synchronizing point at SNR 7

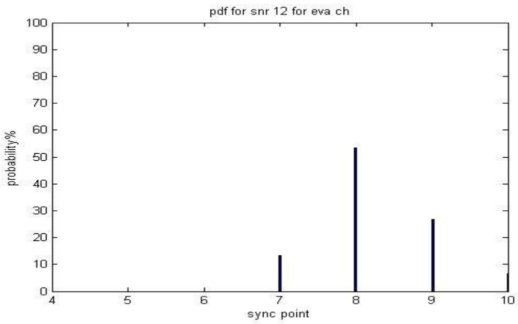

Fig12: probability of the occurrence of the synchronizing point at SNR 12

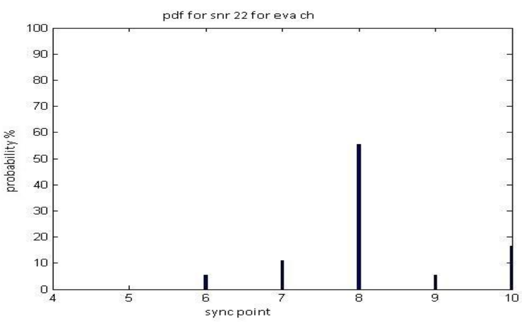

Fig13: probability of the occurrence of the synchronizing point at SNR 22

IV. CONCLUSION AND FUTURE SCOPE:

LTE SIMULATOR is simple to use and it can be available for educational purposes, allowing students and researchers to test the performance of Signal Processing in an easy-to-use MATLAB framework and also we can compare and test our customized modules. LTE simulator is thus compatible with experimental studies on most aspects.

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REFERENCES :

i. *'A Low-Power Low-Cost Design of Primary Synchronization Signal Detection' ieee transactions on very large scale integration (vlsi) systems, vol. 20, no. 7, july 2012*

ii. *http://www.mathworks.in/help/lte/index.html.*

iii. *'Cell Search and Uplink Synchronization in LTE' International Journal of Scientific & Engineering Research, Volume 4, Issue 5, May-2013*

iv. *'Research on Symbol Synchronization Algorithm of LTE System' Proceedings of the 2nd International Conference on Computer Science and Electronics Engineering (ICCSEE 2013)*

v. *LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Long Term Evolution (LTE) physical layer; General description (3GPP TS 36.201 version 8.3.0 Release 8)*

vi. *LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation (3GPP TS 36.211 version 8.6.0 Release 8)*

vii. *Design and Analysis of an Efficient Primary Synchronization Signal Detector ,American Journal of Engineering Research (AJER) e-ISSN: 2320-0847 p-ISSN : 2320-0936 Volume-2, Issue-4, pp-75-85.*

viii. *3GPP; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding*

ix. *LTE – The UMTS Long Term Evolution: From Theory to Practice StefaniaSesia, IssamToufik and Matthew Baker.*

x. *'The Role of Synchronization in DigitalCommunications Using Chaos—Part I:Fundamentals of Digital communications'ieee transactions on circuits and systems—i: fundamental theory and applications, vol. 44, no. 10, october 1997*