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Effects of AWGN channel and Eb/No on the system performance in LTE Downlink Transport Channel using QPSK Modulation

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Abstract— To efficiently support various QoS classes of services, LTE adopts a hierarchical channel structure. There are three different channel types defined in LTE—logical channels, transport channels, and physical channels, each associated with a service access point (SAP) between different layers. These channels are used by the lower layers of the protocol stack to provide services to the higher layers. Logical channels provide services at the SAP between MAC and RLC layers, while transport channels provide services at the SAP between MAC and PHY layers. Physical channels are the actual implementation of transport channels over the radio interface.

In this paper Downlink Transport Channel (DL-SCH) Processing using QPSK modulation is being studied. in order to reduce the proportion of the error associated with Downlink Transport Channel (DL-SCH) Processing. The study looks at the effect of varying Eb/No and/or signal to noise ratio in order to reduce the error rate to near zero in the code word block . The simulation results show that error become negligible when SNR for the channel is 8.092 db with Eb/No of 0.6 .

Keywords- LTE, DL-SCH , Downlink Transport Channel, QPSK.

I. INTRODUCTION

This LTE standard is marketed as 4G Long Term Evolution (LTE). The 3GPP LTE system marks the evolutionary move from third generation of Universal Mobile Telecommunication System (UMTS) to fourth generation mobile technology. It promises high peak data rates for both uplink and downlink transmission, spectral efficiency, low bit rates, and so on.[1] The LTE transport channels vary between the uplink and the downlink as each has different requirements and operates in a different manner. Physical layer transport channels offer information transfer to medium access control (MAC) and higher layers. Physical channels are mapped to specific transport channels Transport channels are SAPs for higher layers. Each physical channel has defined algorithms for Bit scrambling, Modulation, Layer mapping, CDD precoding and Resource element assignment. The PDSCH is utilized basically for data and multimedia transport. It therefore is designed for very high data rates. Modulation options therefore include QPSK, 16QAM and 64QAM. Spatial multiplexing is also used in the PDSCH. In fact, spatial multiplexing is exclusive to the PDSCH. It is not used on either the PDCCH or the CCPCH [2].Transport channel analysis in LTE is being researched by many. The bit error rate (BER) performance of the Cyclic Redundancy Check (CRC) coded Long Term Evolution (LTE) MIMO-OFDM system under various digital modulations (BPSK, QPSK and 16PSK) over an additative white Gaussian noise (AWGN) and other multi path fading (Raleigh and Rician) channels shows that BPSK outperforms the other techniques [1]. Throughput and BER for PDSCH and PUSCH are analyzed in [3], where results show that for both PDSCH and PUSCH throughput increases and BER decreases as SNR for the channel increases when modeled by AWGN, Rayleigh and Rician noisy channels under QPSK, 16QAM and 64QAM modulation schemes. QPSK performed better for the BER analysis. Downlink and Uplink performance analysis under QAM, 16QAM and 64QAM modulation schemes with additive noise channel AWGN and fading channel Rayleigh and Rician. This study showed that bit loss and packet loss are zero for AWGN channel under all the modulation schemes. Rayleigh channel has higher bit and packet loss than Rician channel for QAM and Rician has higher bit and packet loss for the other two modulation schemes [4]. The authors in [5] evaluated the performance of a LTE system using Simulink by checking BER for three modulation techniques namely QPSK, 16QAM and 64QAM and reached the conclusion that the 1/3-Turbo channel coded LTE model performs much better in terms of BER than the non-coded model and QPSK outperformed the other two schemes.

In this paper the effects of additive noise AWGN channel and Eb/No on the system performance of Downlink Transport Channel (DL-SCH) Processing using QPSK modulation is being studied in order to reduce the error rate to near zero in the code word block in Downlink Transport Channel (DL-SCH) Processing . This paper is organized as follows: section II structure of downlink transport channel processing, section III the transport block structure, IV simulation and results and V conclusions.

II. STRUCTURE OF DOWNLINK TRANSPORT CHANNEL (DL-SCH) PROCESSING

Transport channels provide the interface between the MAC layer and the physical layer. The Downlink Shared Channel (DL-SCH) is the main downlink transport channel type in LTE and is used for both user data and dedicated control information

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as well as part of downlink system information [2]. A 24-bit CRC is added to each transport block figure 1 and the CRC allows for receiver-side detection of errors in the decoded transport block ,the corresponding error indication is then used by the downlink hybrid –ARQ[2] .

The downlink transport channel processing for the shared channel at the base station (eNodeB) includes[2]

- CRC insertion per transport block,
- Code block segmentation including per-code-block CRC insertion, figure 2.
- Turbo coding,
- Rate matching, and
- Code block concatenation,

In terms of the more detailed transport-block structure, LTE has adopted a similar approach as was adopted for HSPA[6]

- In case of single-antenna transmission, there is a single transport block of dynamic size for each TTI.
- In case of multi-antenna transmission , there can be up to two transport blocks of dynamic size for each TTI

III. THE TRANSPORT BLOCK STRUCTURE

Figure .1. CRC insertion per transport

Minimum code block size, Z=40 bits and maximum code block size, Z=6144 bits as shown in figure 3 ,defined for LTE turbo-coder internal interleaver "including CRC"[1]. and using CRC checks at the code-block level to stop the iterative decoder for correctly decoded blocks.

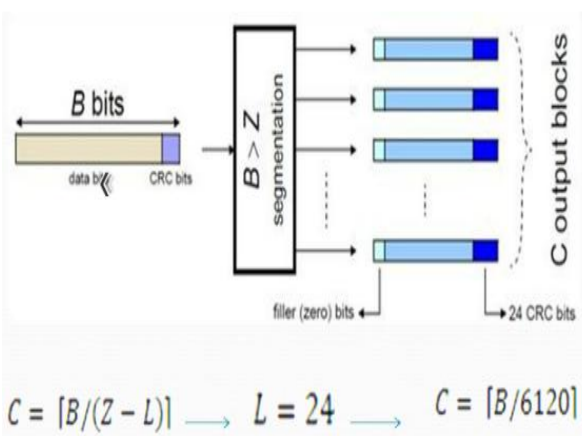

Figure .2. code-block segmentation and per-code-block

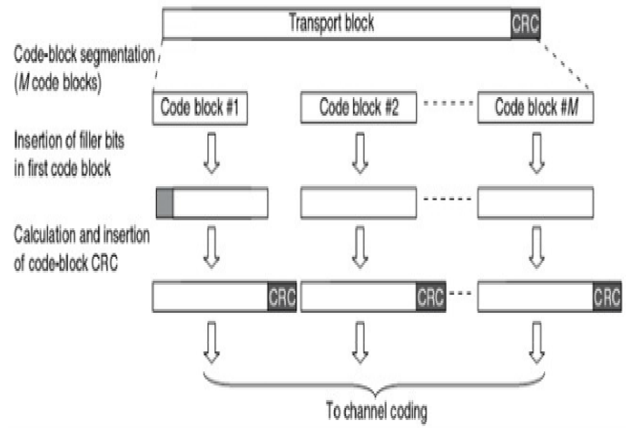

Figure 3. Transport Channel (DL-SCH) Processing

Due to the turbo-coding interleaver block lengths supported by LTE (a maximum of 6144 bits), any transport block that exceeds this size has to be segmented into smaller code-blocks. Based on the transport block size that is specified in the Model Parameters block, the model determines the number of segments (code-blocks) and processes them sequentially (TB Channel Coding block). Based on the sizes Section 7.1.7.2 of 3GPP TS 36.213 specifies, no filler bits are necessary as a part of the segmentation process. For multiple code-blocks per transport block, a 24-bit CRC is calculated and appended to each code block. This allows for early detection of correctly decoded code blocks and, as a result, early termination of the iterative decoding for that code block.

A. Transport Channels: How to Transmit

The transport channels are used by the PHY layer to offer services to the MAC layer. A transport channel is basically characterized by how and with what characteristics data is transferred over the radio interface, that is, the channel coding scheme, the modulation scheme, and antenna mapping. Compared to UTRA/HSPA, the number of transport channels

in LTE is reduced since no dedicated channels are present.

The additional (24 bits) CRC early detection correctly decoded code blocks and early termination of the iterative decoding of the code block. and reduced terminal processing effort and power consumption and additional error-detection capabilities reduce the risk for undetected errors in the decoded transport block only the Turbo coding is applied in case of DL-SCH transmission also for the PCH and MCH transport channel as HSPA.

B. Downlink Transport Channels

Downlink Shared Channel (DL-SCH): Used for transmitting the downlink data, including both control and traffic data, and thus it is associated with both logical control and logical traffic channels. It supports H-ARQ dynamic link adaption, dynamic and semi-persistent resource allocation, UE discontinuous reception, and multicast/broadcast transmission. The concept of shared channel transmission originates from HSDPA, which uses the High-Speed Downlink Shared Channel (HS-DSCH) to multiplex traffic and control information among different UEs. By sharing the radio resource among different UEs the DL-SCH is able to maximize the throughput by allocating the resources to the optimum UEs.

IV. SIMULATION AND RESULTS

In this study a Simulink implementation using both Simulink-based blocks and MATLAB-based System objects from the Communications System Toolbox™ are used. The selected modulation scheme is QPSK and CRC checks are used at the code-block level to stop the iterative decoder for correctly decoded blocks as shown in figure .4. This configuration explores the effects of additive noise AWGN channel and Eb/No on the system performance. Reducing the proportion of error it needs to calculate and append a 24-bit CRC to the generated transport block. This allows for detection of errors at the receive end for the decoded block. After the detection of errors, the error rate can be reduced by an increase in signal to noise ratio of AWGN channel and/or E_b/N_o of the bit stream . So that the error rate can be reduced near to zero in the codworde block in Downlink Transport Channel (DL-SCH)

Processing. The parameters which were set for the simulation are listed in table 1 below:

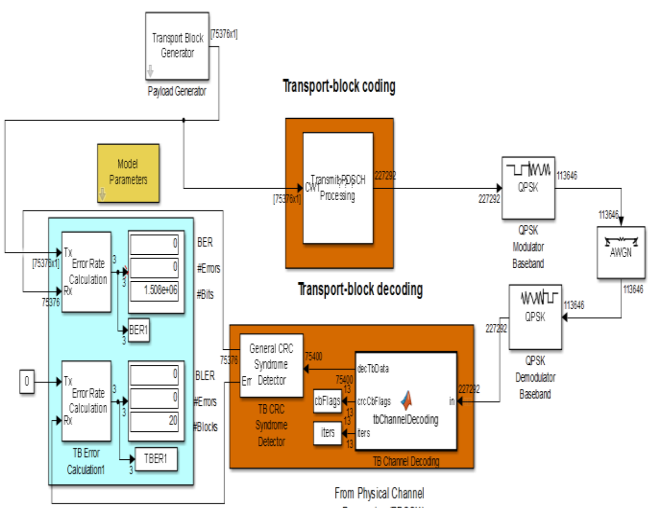

Figure .4. Downlink Transport Channel (DL-SCH) Processing

Table 1 simulation model parameters

parameter	value
Model parameters	
Transport block length	75376 bit
E_b/N_o	0.6
Computation mode	Entire frame
QPSK modulation	
Phase offset	$\frac{\pi}{4}$
Input type	Bit
Output data type	Double
AWGN channel	
SNR	8.902 db

The simulation was run several times for different values o for AWGN SNR and Eb/No for bit stream, where the results are shown in Figs(5 & 6). Fig. 5 shows transport blocks and their associated code blocks in Downlink Transport Channel (DL-SCH) Processing using QPSK modulation technique where there is no errors in the code blocks in each transport block . Fig. 6 shows the relationship between SNR of AWGN channel and E_b/N_o of bit stream, where it is evident that SNR will decrease as E_b/N_o increases and vise versa.

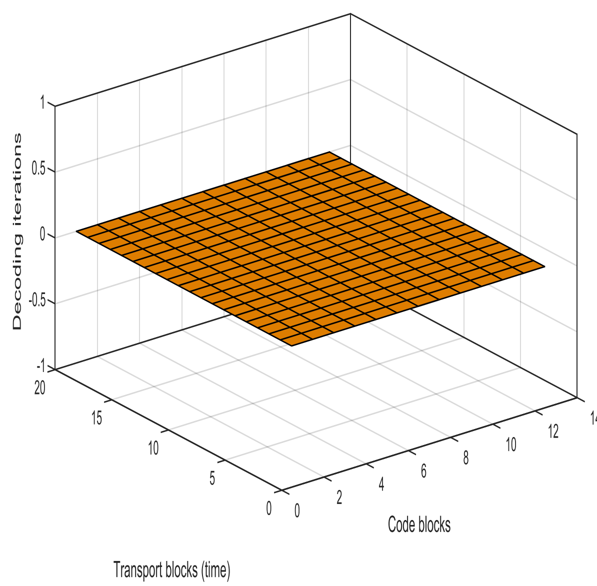

Figure .5. codword in transport block of data modulation QPSK

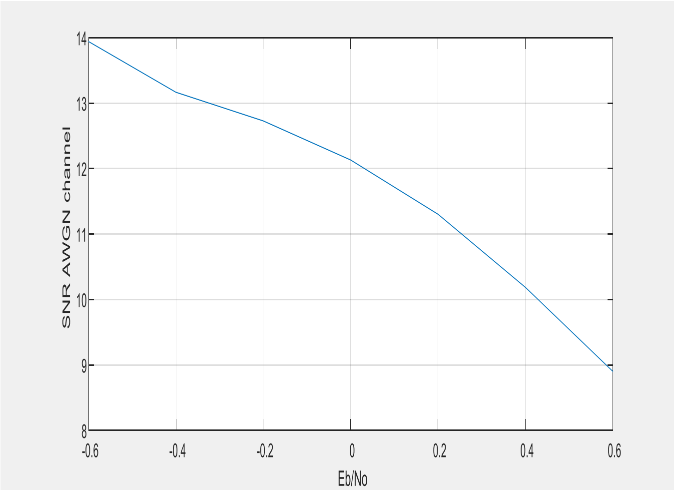

Figure 6 relationship between SNR and E_b/N_o

V. Conclusion

In this paper the Downlink Transport Channel (DL-SCH) Processing performance using QPSK modulation scheme with AWGN channel under various SNR values and bit error rate E_b/No in order to reduce the proportion of error in the Downlink Transport Channel (DL-SCH) and as result it was found that the most appropriate SNR value was 8.902 db for the a value of 0.6 db for E_b/N_o rate which gives zero errors in the code blocks of the transport blocks for the simulated model , which took 13 decoder iterations.

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