Performance of Priority-based Scheduler in LTE-Advanced for Coded Models

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Abstract- Scheduler is part of MAC Layer that executes fair throughput. A good scheduler provides high Quality of Service (QoS) and work towards getting better throughput. There are varieties of Schedulers based on different factors such as fairness, maximum feedback, etc. Priority Scheduler is based on the need of the service to be catered. We have designed a priority based scheduler on the top of ZF-MUMIMO scheduler. The Proposed scheduler is two-level scheduler. We will study the performance of designed Priority scheduler for Binary Symmetric Channel and M-ary Channel Models, in this paper.

Index Terms- ZF-MUMIMO Scheduler, Frame Error Rate (FER), Cell-Specific, UE Specific, Binary symmetric Channel, M-ary channel.

I. Introduction

As the technology advances we come across several new inventions as per the need of Human being. There is also a competition to discover the way to satisfy the quench of throughput by various Scientists and Researchers. We require the throughput at the required level as desired by us but if we badly need some of our application to have executed in short span of time, we may fail some time. Depending on the need we want our work to be done. So we have developed the priority scheduler so that our need get catered according to the priority. The rest of the paper is organized in to four sections. The parameter for the setup of testing the scenario is explained in section II. The explanation of Priority scheduler, Binary symmetric Channel and M-ary channel Models is made in Section III. In section IV, the performance of priority scheduler in Binary symmetric Channel and M-ary channel Models is presented. The section V presents conclusions.

II. Parameters for Scenario Conducted

In order to carry out the simulation and get results we need to setup certain parameters in Simulation tool. These parameters are set according to the compatibility of LTE Advanced technology. The Parameters are mentioned as below

Channel Model	Binary Symmetric Channel M-Ary Channel
NSNR (Normalized Signal-to-Noise Ratio)	100-Binary Symmetric Channel 30-M-Ary Channel
Number of transmitting Antennas (nTX)	4
User count (nUE)	5
Simulation Type	LTE-A-MUMIMO
Carrier frequency	2.1e+09
No of Base stations (nBS)	1
Bandwidth	1.4e+6
Subcarrier Spacing	15000
Cyclic Prefix	normal
Simulation type	Parallel
Pathloss Model	Activated
Sampling Time	5.2083e-07
OFDMN Symbol	140
Number of Sub frames	1000
Scheduled TTIs	132
HARQ process count	8
Maximum HARQ retransmission	0
Base scheduler	Priority scheduler based on ZF-MUMIMO
Filtering	’Block Fading’
Channel model Type	’flat Rayleigh’
Time Correlation	’independent’
Interpolation Method	’shift to nearest neighbor’
Propagation Condition	’NLOS’
Sample Density	2
Uniform Time Sampling	Applied
Traffic model	Data packet traffic + FTP traffic + Full Buffer traffic + Gaming traffic+ HTTP traffic + Video traffic + VoIP traffic

III. Explanation about the System

- Priority Scheduler:

The priority scheduler is a two-level Scheduler. The base scheduler is ZF-MUMIMO on which priority factor governs. Selecting the packet on the top layer of scheduler based on priority factor which in turn depends on:

- Response Time Expected by Users
- Delay
- Buffer length

Response Time Expected by Users: The users.’ expected response time is the time elapsed between sending a request and the reception of the first response by the user. Higher the response time expected by the users, lower the Priority factor.

Delay: The network transmits delay is the time elapsed between the emission of the first bit of a data block by the transmitting end-system, and its reception by the receiving end-system. Higher the delay there is a corresponding increase in Priority factor. The delay consists of Tap delay, HARQ delay and Uplink delay altogether.

Delay =Tap delays +HARQ delay + uplink delay;
Tap delay=Interpolator delay;

Jitter: In transmission technology, jitter refers to the variation of delay generated by the transmission equipment. This parameter doesn't come into picture because this is user specific.

Buffer length: Larger Buffer length results in lesser data overflow and increase in the throughput. As buffer length increases the Priority factor increases. This is because the traffics which are non real time have a high buffer length and those who are Real time traffic are having very less buffer length.

Priority factor=PF,Response Time Expected by Users=X
Delay=D,Buffer length=B

PF=B/(X×D);
Response Time Expected by Users (X) for various traffic models is as below:
Full Buffer Model=20 msec
VoIP traffic model=50 msec
HTTP traffic model=400 msec
Data packet traffic model=150 msec
Video traffic model=200 msec
Gaming traffic model=250 mSec
FTP traffic model=5 Sec.

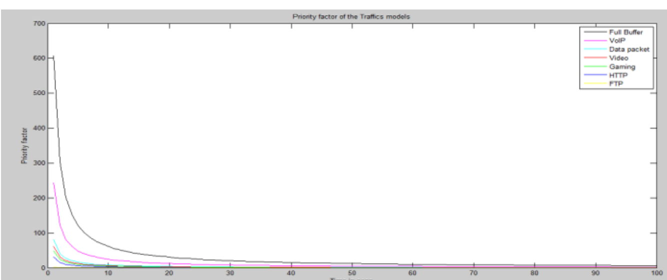

Fig.1 Dimensionless priority factor based on buffer length and delay

The maximum Priority factor generated from whichever traffic will be selected for the scheduler under ZF-MUMIMO which is base scheduler. This is how we are able to send only those traffics which have highest priority at a particular instant among all the traffics needed to be sending across. In ZF-MUMIMO scheduler given a set of users, the scheduler selects more than one user and transmits independent data to them simultaneously by using zero-forcing beam forming [1].

Binary symmetric Channel: These are common communication Channels used in Information theory and coding Theory. When a transmitter wants to transmit a bit and receiver receives it, the bit is assumed to be 0 or 1and also assumed to received correctly. But bit 1/0 can also be flipped with a small probability also called as crossover probability. This is the simplest channel and hence used frequently. A binary symmetric channel with crossover probability p denoted by BSC_p, is a channel with binary input and binary output and probability of error p; that is, if S is the transmitted random variable and Y the received variable, then the channel is characterized by the conditional probabilities

$\Pr(R = 0 \mid S = 0) = 1 - p$
$\Pr(R = 0 \mid S = 1) = p$
$\Pr(R = 1 \mid S = 0) = p$
$\Pr(R = 1 \mid S = 1) = 1 - p$

It is assumed that $0 \le p \le 1/2$. If $p > 1/2$, then the receiver can swap the output (interpret 1 when it sees 0, and vice versa) and obtain an equivalent channel with crossover probability $1 - p \le 1/2$.

M-ary Symmetric channel: It is an M-ary input/M-ary output channel with transition probabilities P (y|x) that depends on the geometry of M-ary signal constellation and the statistics of the noise. Because the channel is symmetric the capacity is equal to the mutual information of the channel with uniform input probabilities $P_r(x) = 1/M$.

IV. PERFORMANCE OF PRIORITY SCHEDULER

We will analyze the performance of Priority Scheduler for Binary symmetric Channel and M-Ary channel. There are two divisions for comparison of each of the parameters i.e. Cell Specific and UE specific. Cell specific is more important than UE Specific. Under UE Specific we are evaluating the first UE parameter out of 5 UEs.

- Throughput Measurement

In communication networks, such as VoIP, Ethernet or packet radio, throughput is the average rate of successful message delivery over a communication channel. This data may be delivered over a physical or logical link, or pass through a certain network node. The throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot. In our paper we are using Kbits/sec. The system throughput is the sum of the data rates that are delivered to all terminals in a network.

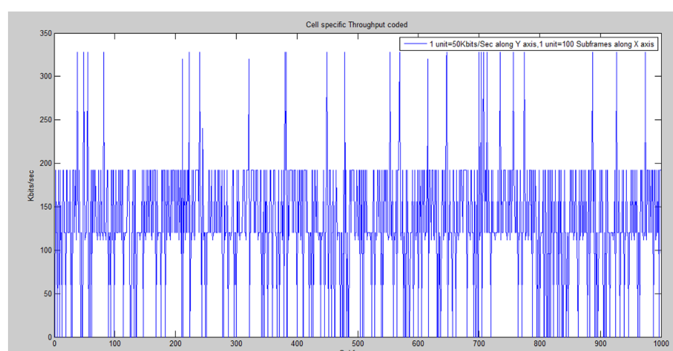

Fig.2 Cell specific throughput coded Binary symmetric Channel Model

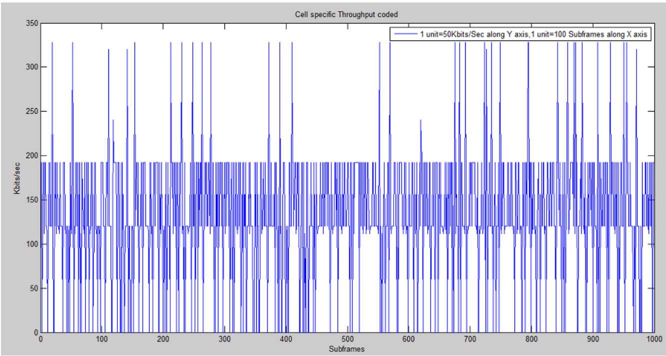

Fig.3 Cell specific throughput coded in M-Ary Channel Model

The Cell specific throughput coded in Binary symmetric Channel Model is shown in fig. 2. Comparing it with throughput coded in M-ary Channel model from fig.3, we confer that throughput coded is slightly greater in M-ary Channel Model.

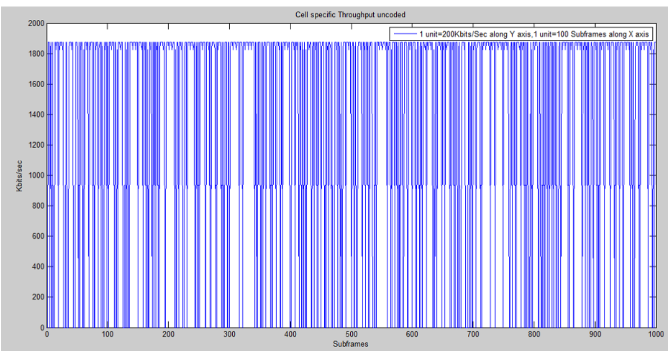

Fig.4 Cell specific throughput uncoded in Binary symmetric Channel Model

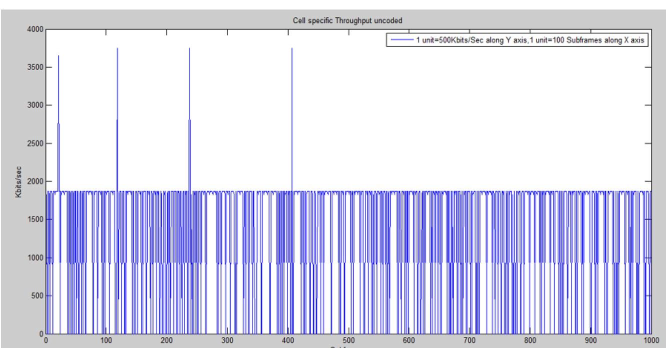

Fig.5 Cell specific throughput uncoded in M-Ary Channel Model

The Cell specific throughput uncoded in Binary symmetric Channel Model is shown in fig. 4. Comparing it with throughput uncoded in M-ary Channel model from fig. 5, we confer that there is no major difference in throughput uncoded between the two except few spikes in M-ary Channel Model.

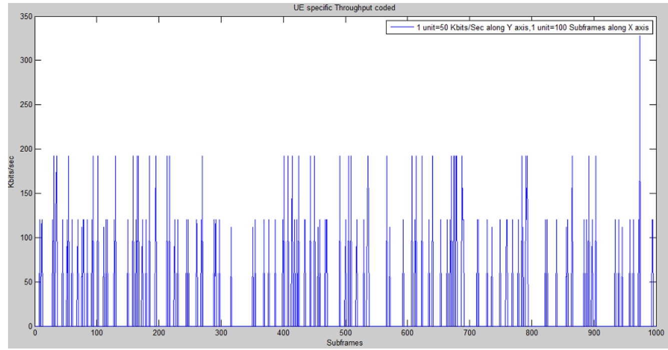

Fig.6 UE specific throughput coded in Binary symmetric Channel Model

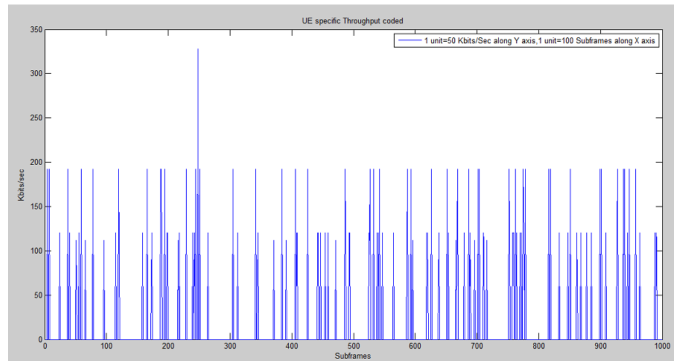

Fig.7 UE specific throughput coded in M-Ary Channel Model

The UE specific throughput coded in Binary symmetric Channel Model is shown in fig.6. Comparing it with throughput coded in Binary symmetric Channel Model from fig.7, we confer that there is slightly greater number of spikes in throughput of size 190 kbits/sec in M-ary Channel Model then Binary symmetric Channel Model.

The UE specific throughput uncoded in both M-Ary Channel Model and Binary symmetric Channel Model is zero.

- Frame Error Rate Measurement

Frame error rate (FER) has almost the same meaning as BER (Bit error rate), but the error rate calculation is between frame and not bit. When designing a code, the exact BER criteria might not be tractable. Therefore, PER (Packet error rate) is used instead. In real system, we do not have access to BER or PER, but only FER through CRC.

Frame Error Rate (FER) measurement is used to test the performance of a mobile station's receiver. During an FER measurement, the test set sends a sequence of frames to the mobile station. Each frame contains CRC (Cyclic Redundancy Code) bits, which provide frame quality indicator and allow the mobile station to verify that it has correctly decoded a frame. The mobile station is put into a loopback service option and makes its best attempt to decode each received frame sent from the test set. Once the mobile station determines the Category Type that specifies whether the frame received is a good frame, bad frame, frame erasure, or a frame blanked by signaling, the mobile station encodes and re-transmits the frame, with the first two bits replaced with the Category Type information, back to the test set. The test set compares each received frame to the corresponding frame that was sent and validates the Category Type information, then determines the measurement results. The test set keeps a running count of the measured frames and the number of frames that contain bit errors. Confidence level testing is a feature of FER measurements that applies statistical analysis to FER measurements so that pass/fail test results can be obtained in the shortest possible time.

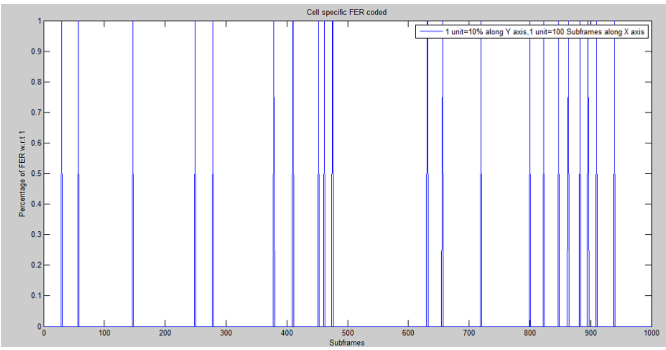

Fig.8 Cell specific FER coded in Binary symmetric Channel Model

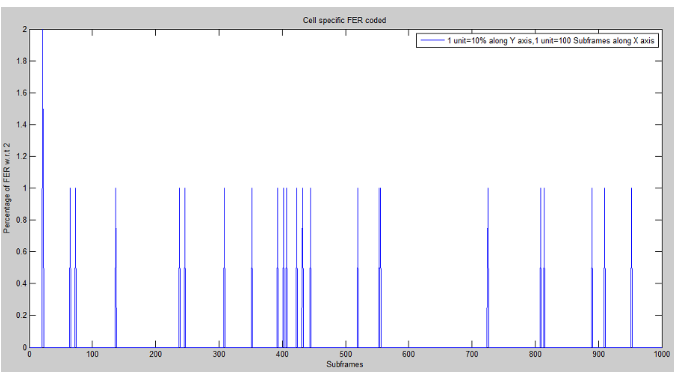

Fig.9 Cell specific FER coded in M-Ary Channel Model

The Cell specific FER coded in Binary symmetric Channel Model is shown in fig.8. Comparing it with FER coded in M-ary Channel Model from fig.9, we confer that M-ary Channel Model has Frame errors severity almost half that of Binary symmetric Channel Model.

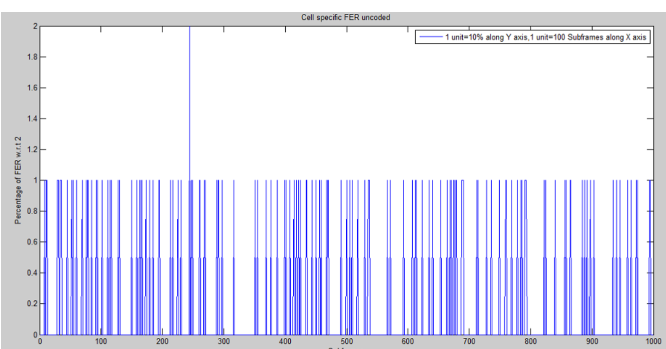

Fig.10 Cell specific FER uncoded in Binary symmetric Channel Model

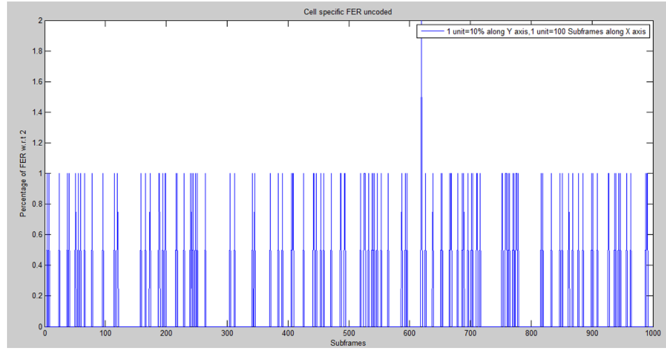

Fig.11 Cell specific FER uncoded in M-Ary Channel Model

The Cell specific FER uncoded in Binary symmetric Channel Model is shown in fig.10. Comparing it with FER coded in M-ary Channel Model from fig.11, we confer that FER uncoded in Binary symmetric Channel Model is almost same as that of M-Ary Channel Model. It is also observed that FER coded results in very good performance compared to FER uncoded.

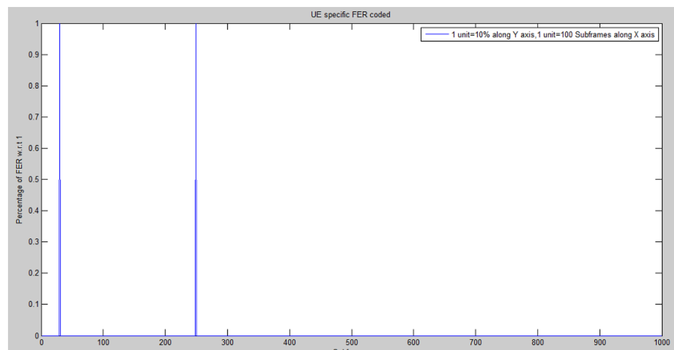

Fig.12 UE specific FER coded in Binary symmetric Channel Model

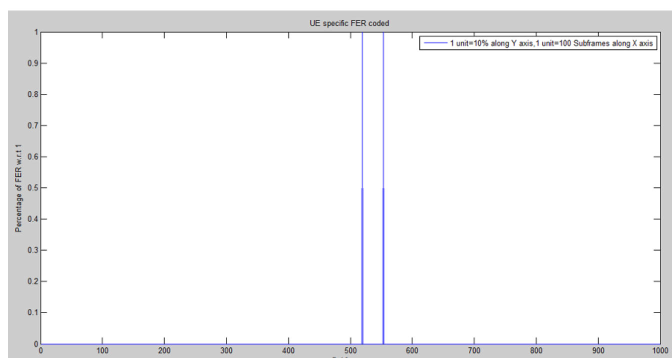

Fig.13 UE specific FER coded in M-Ary Channel Model

The UE specific FER coded in Binary symmetric Channel Model is shown in fig.12. Comparing it with FER coded in M-ary Channel Model from fig.13, we confer that Binary symmetric Channel Model has same FER as that of M-Ary Channel Model. It is also observed that FER coded results in very good performance compared to FER uncoded.

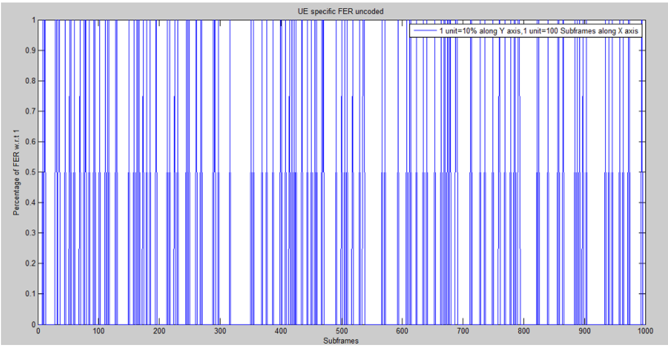

Fig.14 UE specific FER uncoded in Binary symmetric Channel Model

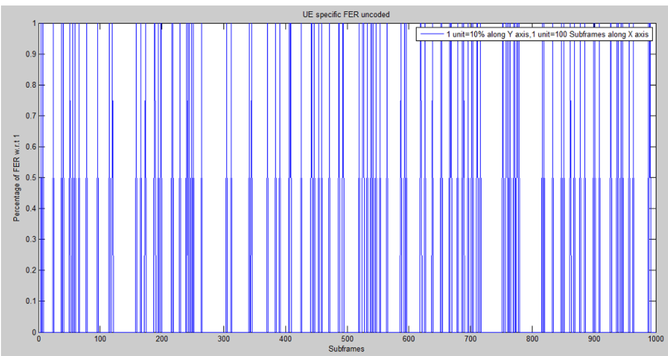

Fig.15 UE specific FER uncoded in M-Ary Channel Model

The UE specific FER uncoded in Binary symmetric Channel Model is shown in fig.14. Comparing it with FER uncoded in M-Ary Channel Model from fig.15, we confer that both uncoded FER in both the Channel Models are identical. It is also observed that in both the cases FER coded results in very good performance compared to FER uncoded

- Bit Errors Measurement

The main reasons for the degradation of a data channel and the corresponding BER is noise and changes to the propagation path (where radio signal paths are used). Both effects have a random element to them, the noise following a Gaussian probability function while the propagation model follows a Rayleigh model. This means that analysis of the channel characteristics are normally undertaken using statistical analysis technique.

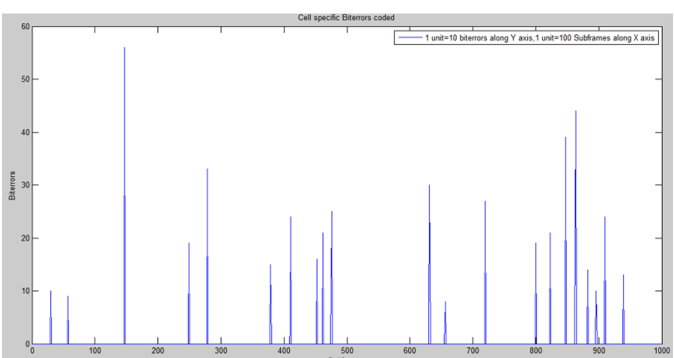

Fig.16 Cell specific bit errors coded in Binary symmetric Channel Model

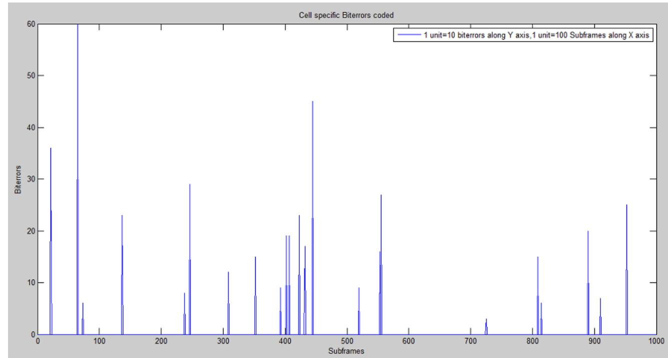

Fig.17 Cell specific bit errors coded in M-Ary Channel Model

The Cell specific Bit errors coded in Binary symmetric Channel Model is in fig.16 comparing it with bit errors coded in M-ary Channel Model, from fig.17 we confer that Bit errors coded in Binary symmetric Channel Model are more then M-Ary Channel Model.

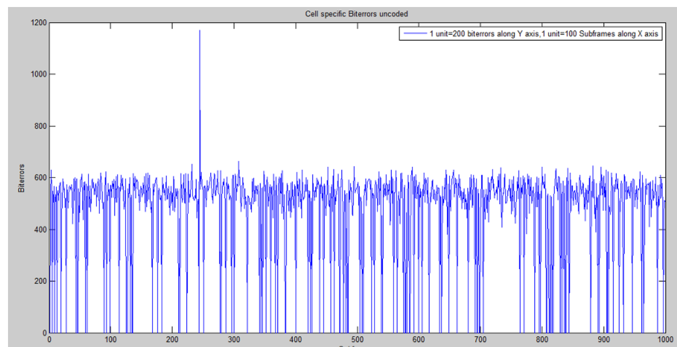

Fig.18 Cell specific bit errors uncoded in Binary symmetric Channel Model

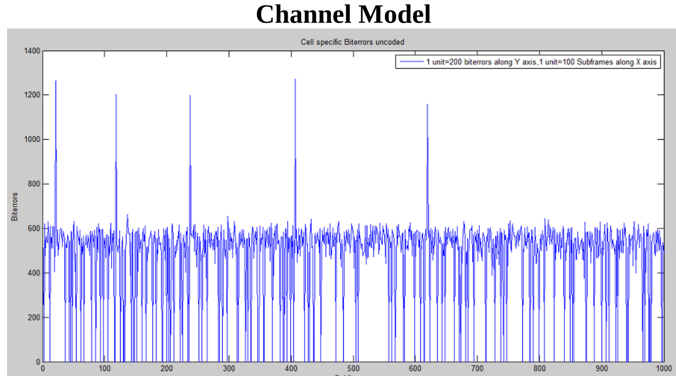

Fig.19 Cell specific bit errors uncoded in M-Ary Channel Model

The Cell specific Bit errors uncoded in Binary symmetric Channel Model is shown in fig.18. Comparing it with Bit errors uncoded in M-ary Channel Model from fig.19, we confer that both are high and same expect few spikes greater in M-Ary Channel Model. It is also observed that in both the cases Bit errors coded results in very good performance compared to Bit errors uncoded.

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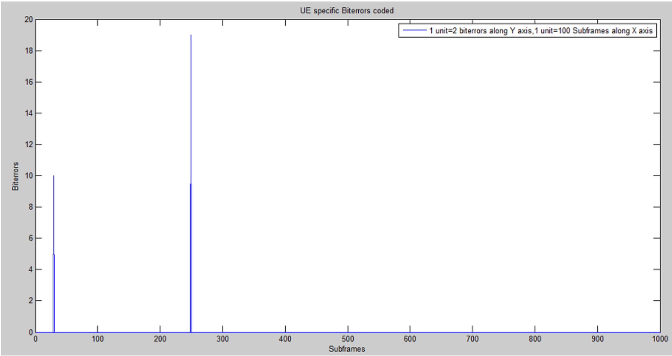

Fig.20 UE specific bit errors coded in Binary symmetric Channel Model

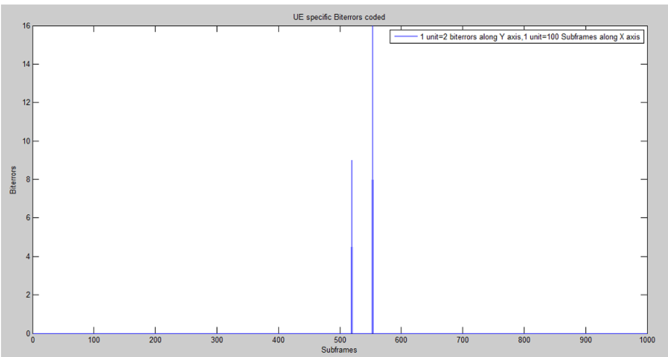

Fig.21 UE specific bit errors coded in M-Ary Channel Model

The UE specific Bit errors coded in Binary symmetric Channel Model is shown in fig.20. Comparing it with Bit errors coded in M-Ary Channel Model from fig.21, we confer that Bit errors Coded in Binary symmetric Channel Model is same as that of when compared with M-Ary Channel Model. Bit errors coded results in very good performance compared to Bit errors coded.

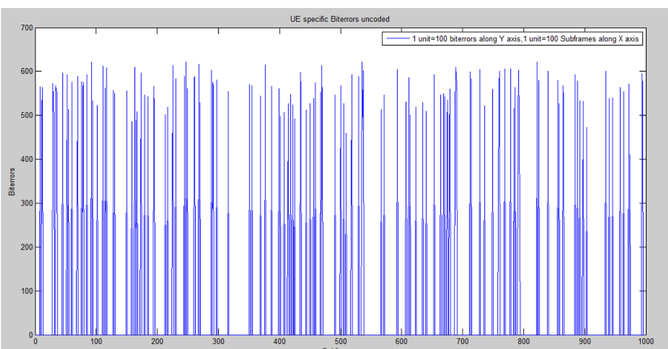

Fig.22 UE specific bit errors uncoded in Binary symmetric Channel Model

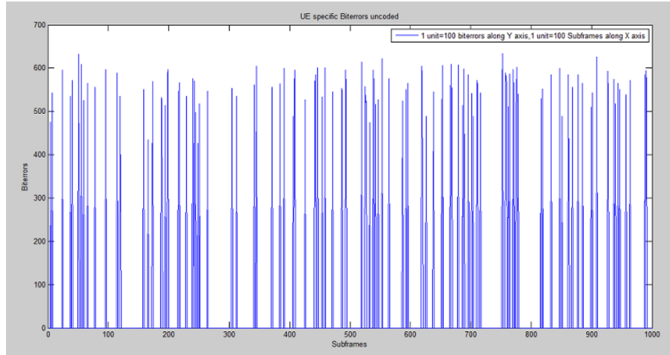

Fig.23 UE specific bit errors uncoded in M-Ary Channel Model

The UE specific Bit errors uncoded in Binary symmetric Channel Model is shown in fig.22. Comparing it with Bit errors uncoded in M-ary Channel Model from fig.23, we confer that both are high and identical.

- Block Size Measurement

Resource Block size: A frame is 10ms in length. Each frame is divided (in the time domain) into 10 sub frames. A sub frame is 1ms in length. Each sub frame is divided (in the time domain) into 2 slots. A slot is 0.5ms in length. Each slot is divided (in the frequency domain) into a number of resource blocks. The number of resource blocks in a slot depends on the channel bandwidth. A resource block is 0.5ms in length and contains 12 subcarriers from each OFDM symbol. The number of OFDM symbols in a resource block depends on the cyclic prefix being used. The resource block is the main unit used to schedule transmissions over the air interface [2].

Transport Block size: Transmission Bandwidth is the number of active Resource Blocks in a transmission. As the bandwidth increases, the number of Resource Blocks increases. The Transmission Bandwidth Configuration is the maximum number of Resource Blocks for the particular Channel Bandwidth. The maximum occupied bandwidth is the number of Resource Blocks multiplied by 180 kHz . The Transport Block Sizes are calculated based on the MCS (modulation and coding scheme), the number of allocated PRBs(Physical resource Blocks) and the number of available REs(Resource Elements) So the transport block size does not increase linearly with the increase of the index itself. We might have the same number of allocated PRBs but the number of available REs will be smaller because of OFDMA symbols carrying PDCCH or the same number of REs in a PRB but different MCS for the allocation.

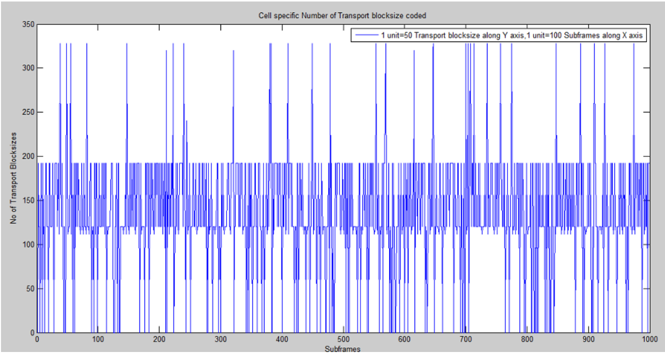

Fig.24 Cell specific block size coded in Binary symmetric Channel Model

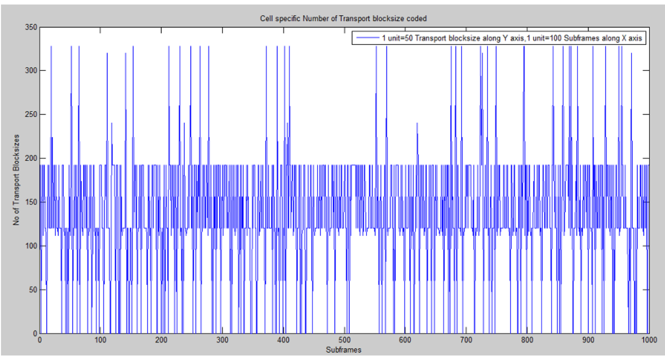

Fig.25 Cell specific block size coded in M-Ary Channel Model

The Cell specific block size coded in Binary symmetric Channel Model is shown in fig.24. Comparing it with block size coded in M-ary Channel Model from fig.25, we confer that block size coded of sizes nearly 330 in M-Ary Channel Model is slightly more when compared with Binary symmetric Channel Model. Rest all Block sizes remain identical in both the schedulers.

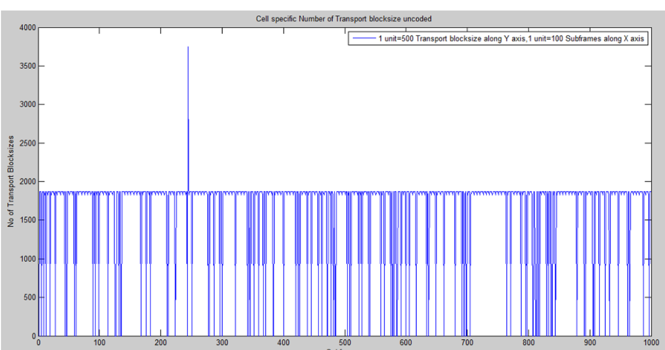

Fig.26 Cell specific block size uncoded in Binary symmetric Channel Model

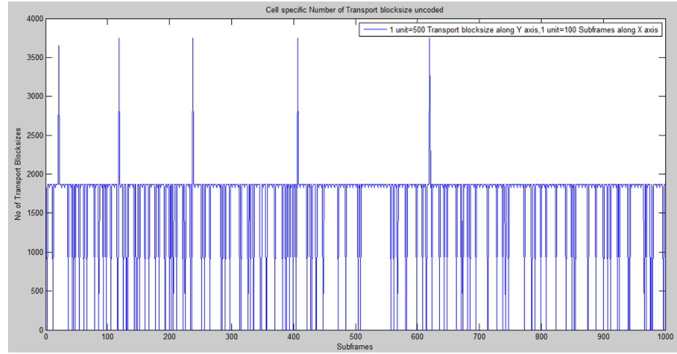

Fig.27 Cell specific block size uncoded in M-Ary Channel Model

The Cell specific block size uncoded in Binary symmetric Channel Model is shown in fig.26. Comparing it with block size uncoded in M-ary Channel Model from fig.27, we confer that block size uncoded in Binary symmetric Channel Model is more or less same when compared with M-ary Channel Model except for few higher spikes in case of M-ary Channel Model. However in both the cases Block size Coded is having better performance than that of Block size uncoded.

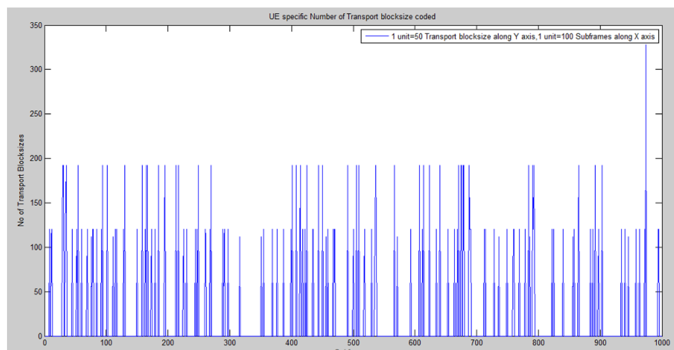

Fig.28 UE specific block size coded in Binary symmetric Channel Model

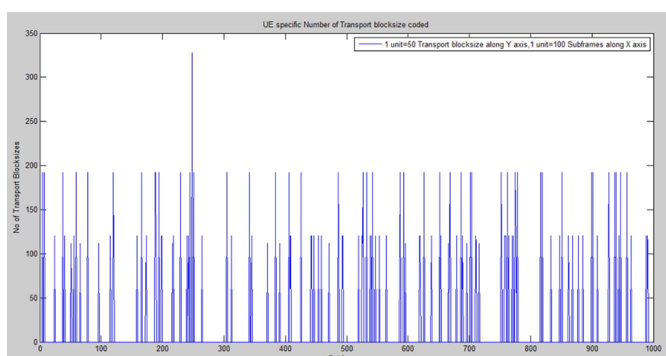

Fig.29 UE specific block size coded in M-Ary Channel Model

The UE specific block size coded in Binary symmetric Channel Model is shown in fig.28. Comparing it with block size coded in M-Ary Channel Model from fig.29, we confer that block size coded in Binary symmetric Channel Model is more or less same when compared with M-ary Channel Model.

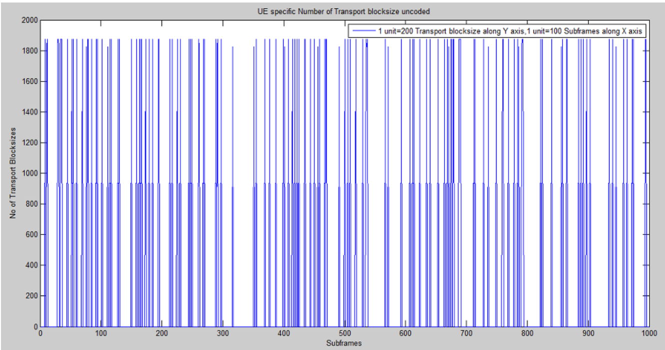

Fig.30 UE specific block size uncoded in Binary symmetric Channel Model

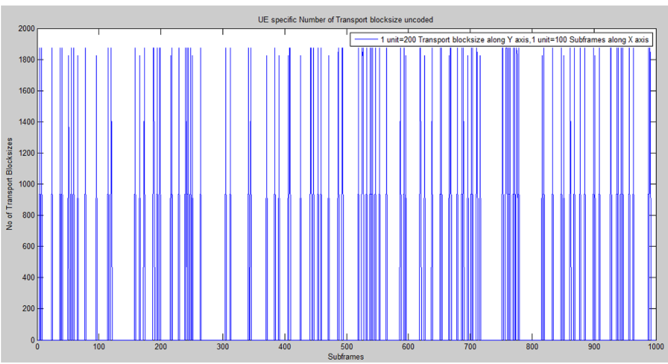

Fig.31 UE specific block size uncoded in M-Ary Channel Model

The UE specific block size uncoded in Binary symmetric Channel Model is shown in fig.30. Comparing it with block size coded in M-ary Channel Model from fig.31, we confer that block size uncoded in Binary symmetric Channel Model is more or less same when compared with M-ary Channel Model. However in both the cases Block size Coded is having better performance than that of Block size uncoded.

V. Conclusions

There are many schedulers, each having its own specific and unique characteristics. Each of the scheduler has certain advantages and disadvantages. Some of schedulers are specific to applications. We have presented results for Binary symmetric Channel Model and M-Ary Channel Model. We have used the cell specific criteria and also the user specific to compare the performance of our proposed Priority Scheduler for Binary symmetric Channel Model and M-Ary Channel Model. In both the cases we used the coded and uncoded parameters like throughput, block size, FER and bit errors to evaluate the performance of the schedulers. The proposed Priority scheduler is best suited for M-Ary Channel Model even the FER is high for it which we have come across the discussion in the paper.

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