Performance Comparison Of Frequency Domain Packet Scheduling With Different Feedback Mechanisms

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ABSRACT

Long term evolution (LTE) is a next generation wireless technology, providing an evolutionary path for 3G/UMTS deployment. Reduction in feedback data in LTE is hot research topic now a days.. In contrast to the circuit switched model of the previous cellular systems, LTE has been designed to support only packet switched services. In this paper, the performance of Frequency domain packet scheduling (FDPS) is compared in terms of probability of retransmission, modulation and coding system (MCS) hitting probability and throughput. This comparison is done under the different feedback scheme. Mainly 3-1 and 2-2 feedback schemes are used in these comparisons.

Key words : LTE, FDPS, OFDMA

INTRODUCTION

The Third-generation partnership project (3GPP) is the standards-developing body that specifies the 3G UTRA and GSM systems. LTE[1] as defined by the 3GPP is the evolution of the Third generation of mobile communications, UMTS. LTE intends to create a new radio - access technology which will provide high data rates, a low latency and a greater spectral efficiency.

Frequency domain packet scheduling (FDPS)[2] is one of the scheduling mechanisms used in Long Term Evolution (LTE). Orthogonal Frequency Division multiple Access (OFDMA) has been selected as the downlink radio access technology for UTRAN Long Term Evolution (LTE) in 3GPP. In this paper performance of Frequency domain packet scheduling (FDPS) is compared in terms of probability of retransmission, modulation and coding system (MCS) hitting probability. This comparison is done under the two different feedback schemes. 3-1 and 2-2 are the two feedback schemes used in these comparisons. When eNB send a reference signal to the user, then user will feback to the all channel state information to the eNB. From these channel state information eNB will allocate the appropriate resource block into corresponding user.

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In order to get the information about the channel, channel state information(CSI) must be fedback to the eNB. Then information from each transmit antennas needs to be fed back. This can leads to the overhead. To solve this issue a codebook is used. So in this project the feed back modes are based on the codebook. In mode 3-1 only on channel quality information (CQI) is fed back to the eNB. That CQI will be best one. In mode 2-2 two channel quality information fed back to the eNB.

Orthogonal Frequency Division Multiplexing (OFDM) has been adopted as the downlink transmission scheme for the 3GPP LTE. A downlink is a transmission from the base station to the mobile station. OFDM divides the transmitted high bit-stream signal into different sub streams and sends these over many different sub-channels. A base station is called Evolved NodeB (eNB) in the Long Term Evolution and the Mobile station is called User equipment (UE) in the Long Term Evolution (LTE).

The downlink physical resource is represented as a time-frequency resource gridconsisting of multiple Resource blocks(RB). A resource block is divided in multiple Resource elements(RE). A scheduler is a key element in the BS and it assigns the time and frequency resources to different users in the cell. Thus a RB is the smallest element that can be assigned by the scheduler.

SYSTEM MODEL

The basic FDPS terminology and frame work including the Node-B where the scheduler is based and the user equipment (UE) is illustrated in Fig.1. To frequency multiplex users in OFDMA, the bandwidth needs to be divided into seperable chunks denoted as resource blocks (RBs). Chunk based adaptation and user multiplexing is preffered for LTE as it reduces the associated signalling overhead[3].

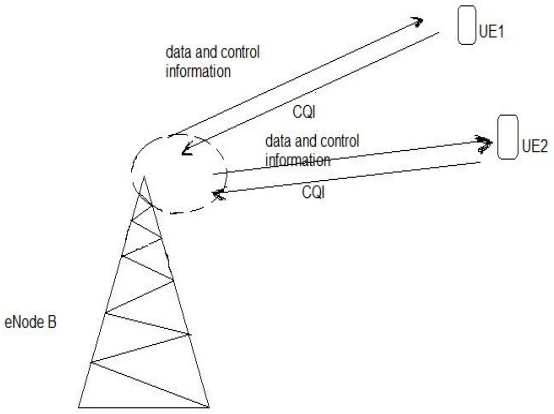

Fig 1 FDPS system model

In mode 3-1 only one CQI information is feedback to the eNB. Here probability ofretransmission will be high because two user has snr that belongs to the same sub band. Then user can't allocate two user to the same sub band. In mode 2-2 two CQI information is feedback to the eNB. Then probability of retransmission is less compared with mode 3-1 because if two user has the snr that belongs to the same sub band then it will check the second CQI[9]. If the second CQI is also has the same criteria that happened to the first one then only it retransmitted. So the probability of retransmission in mode 2-2 is less compared with mode 3-1.[5]

Here two performance is analysed. First one probability of retransmission versus subcarrier and probability of retransmission versus user. In first one, probability of retransmission versus subcarrier at constsnt user, when subcarrier increases probability of retransmission gradually decreases in both case. Because when subcarrier increases the user has feedback values that belongs to different users. In the case of probability of retransmission versus user, the probability of retransmission increases when number of user increases because number of user feedback value is higher here, then probability of feedback data from user that belongs to the same sub band will be high.

The CSI matrix is given by

$$\begin{bmatrix} C_{1,1},C_{1,2},C_{1,3},C_{1,4}.....C_{1,N} \\ C_{2,1},C_{2,2},C_{2,3},C_{2,4}.....C_{2,N} \\ C_{3,1},C_{3,2},C_{3,3},C_{3,,4}.....C_{3,N} \\ C_{4,1},C_{4,2},C_{4,3},C_{4,4}.....C_{4,N} \\ ..... \\ ..... \\ ..... \\ ..... \\ C_{K,1},,C_{K,2},C_{K,3},C_{K,4}.....C_{K,N} \end{bmatrix}$$

N is the number of sub bands and K is number of users.

Equation for probability of retransmission

Equation for probability of retransmission in the case of mode 3-1

Probability of retransmission=1-proability of no retransmission

No retransmission means different users have their best SNR values for different sub bands[4].

Suppose there are N sub bands and K users. First transmitted user has N options to access sub bands. In the case of second user only N-1 options. Except from first user accessed sub bands

. Probability of no retransmission is

$$=\frac{N}{N}*\frac{N-1}{N}*\frac{N-2}{N}\dots\dots\dots\dots \quad (1)$$

similarly, in the case of K user

probability of no retransmission

$$=\frac{1}{N^K}*\prod_{k=0}^{K-1}(N-k) \quad (2)$$

From equation we can write,

Probability of retransmission

$$=1-\frac{1}{N^K}*\prod_{k=0}^{K-1}(N-k) \quad (3)$$

In the case of mode 2-2 there are two CQI is feedback to the eNB. then probability of retransmission is,The basic equation for probability of retransmission=1-probability of no retrnsmission Each user should feedback its best two sub band indices to the eNB. From N sub bands any two can be selected in Nc2 ways. For formulating retransmission probability let us assume users send the feedback to eNB one after the other.

Among Nc2 options first user can send any of the $\sum_{i=1}^{N-1} i$ any of the valid combination.

Similarly second user can send any combination other than the one which was feedback by the user one. And so on.So probability of no retransmission can be obtaineas

$$P=\frac{1}{(Nc_2)^K}*(\prod_{k=0}^{K-1}(\sum_{i=1}^{N-1} i)-k) \quad (4)$$

Then, probability of retransmission

$$P=1-\frac{1}{(Nc_2)^K}*(\prod_{k=0}^{K-1}(\sum_{i=1}^{N-1} i)k)\,\pi r^2 \quad (5)$$

Throughput equation

For finding the throughput equation[7] ,first data rate equation can be calculated

$$\text{Data rate}=R=log_2(1+x)*{}^{RE}/_{t} \quad (6)$$

$log_2(1+x)$is number of bits transmitted.

RE is the number of resource elements transmitted in a sub frame

T is sub frame duration

Number of RE=number of subcarrier*number of Symbols (7)

B= bandwidth

N=number of subcarriers

From these throughput equation can be written as,

Throughput=Th=data rate*bandwidth*frame duration

$$Th=R * {}^{B}/_{N} * t \quad (8)$$

That is,

$$Th=log_2(1+x) * {}^{B}/_{N} * t \quad (9)$$

Modulation and coding system (MCS)

Hitting probability

The equation for MCS hitting probability is

$$p(M \leq m) = \sum_{i=0}^{N-1} P(M = i) \quad (10)$$

SIMULATION RESULTS

The objective of the thesis is to compare the different feedback mechanisms in Frequency domain packet scheduling. K user and N sub band system are considered here. Every user has feedback channel quality information (CQI) to eNB. based on the channel quality information eNB allocate the corresponding sub band to user. In this project performance analysis is done under in terms of probability of retrasmission versus user, probability of retransmission versus subcarrier, modulation and coding system (MCS) hitting probability and throughput versus subcarrier

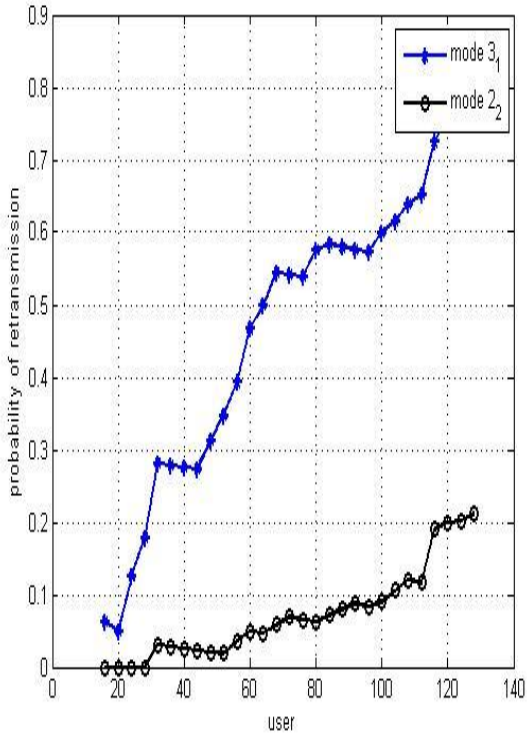

Figure 2Variation of probability of reransmission versus user (pracical)

Consider a system with N sub bands and K users, Figure 2 shows that variation of probability of retransmission with number of users. In the above figure it shows that mode2-2 has the lower probability of retransmission compared with mode 3-1. It is because of user send two feedback information (CQI) to the eNB. in the case of mode 3-1 only one CQI is fedback to the eNB. so in mode 2-2 user can select any of the CQI information for transmission. And also above Figure 2 shows that by increasing the number of user with constant number of subcarrier probability of retransmission increases.

Figure 3 shows that theoretical analysis of probability of retransmission versus user. This graph is based on the equations of probability of retransmission (3.1). By comparing the Figure 2 and 3, it shows that in Figure 3 is straight line compared with Figure 2.

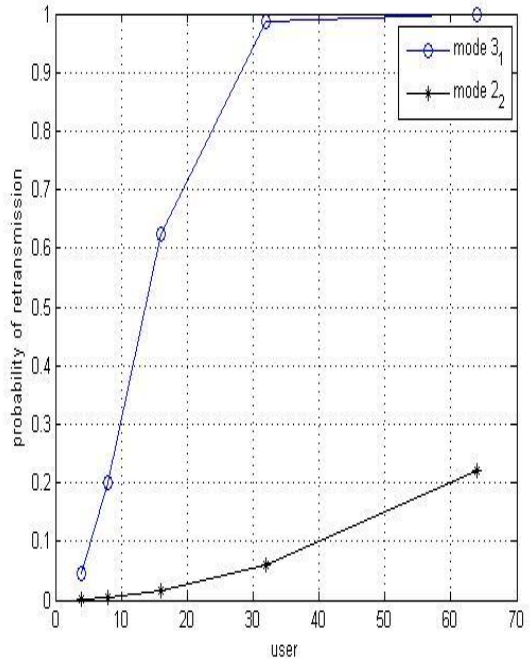

Figure 3 variation of probability of retransmission versus user(theoretical)

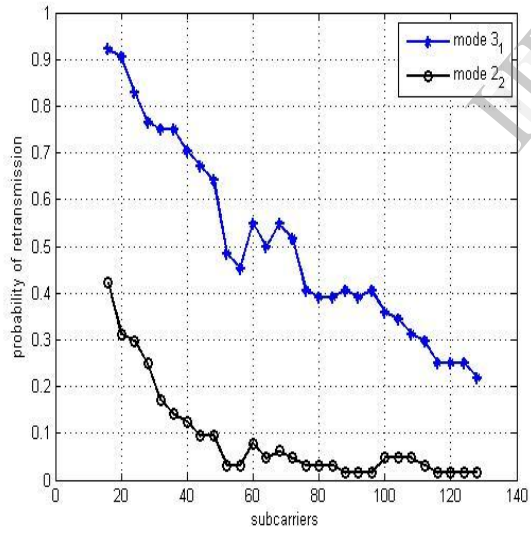

Figure 4 variation of probability of retransmission versus subcarriers (practcal)

Figure 4 shows that practical analysis of variation of probability of retransmission with number of subcarrier. It shows that mode 2-2 is lower probability of retransmission compared with mode 3-1. It also shows that by increasing the number of subcarriers the probability of retransmission also reduces. When number of subcarrier increases users have more options to choose the appropriate sub band for user based on the channel quality information.

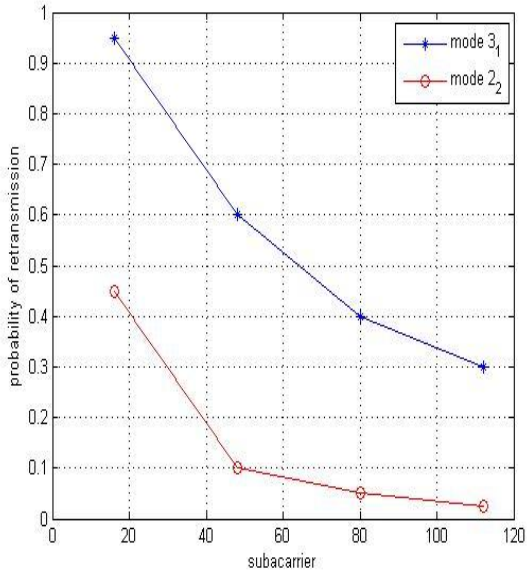

Figure 5 variation of probability of reransmission versus subcarrier (theoretical)

Figure 5 shows that theoretical analysis of variation of probability of retransmission with number of subcarriers.

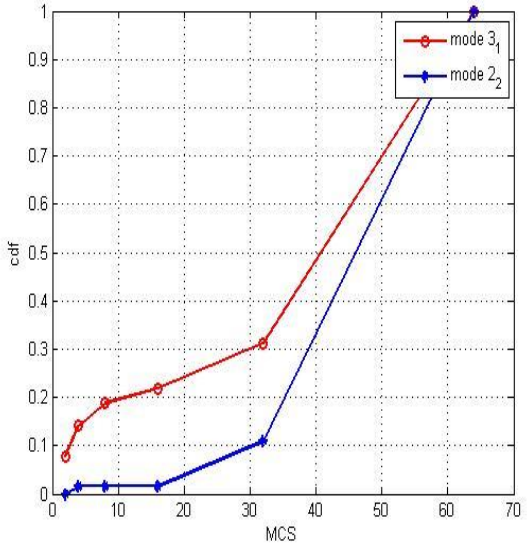

Figure 6 Modulation and coding system hitting system probability

Figure 6 shows the Modulation and coding system (MCS) hitting probability of a system. In mode 2-2has

less probability in lower level modulation by comparing with mode 2-2. That is mode 3-1 has higher probability in lower level modulation. Because in mode 3-1 the probability of retransmission is high. When retransmission occurs in the mode 3-1, then eNB will allocate lower level modulation. So in the case of mode 2-2 the probability of retransmission is less, then user can allocate higher level modulation. It means when SNR value is high, scheduler will allocate higher level modulation. When SNR value is less, then scheduler will allocate lower level modulation.

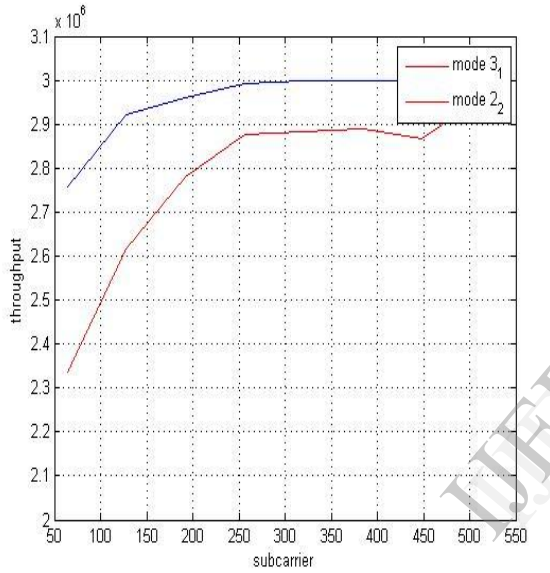

Figure 7 variation of hroughpu versus subcarriers

Figure 7 shows that performance analysis of variation of throughput with number of subcarriers. From the above it shows that in mode 2-2 has high throughput compared with mode 3-1. Because in mode 3-1 probability of retransmission is high compared with mode2-2When number of subcarrier increases throughput also increases. Because when subcarrier number increases feedback information will corresponds to differen sub bands, then eNB can allocate that sub band to particular user.

From these analysis it shown that mode 2-2 is better performance compared with mode 3-1. When number of channel quality information increases then probability of retransmission also increases.

CONCLUSION

In Long Term Evolution (LTE) reduction in feedback data ia very important.for reducing feedback data many different feedback mechanisms are used. In this project performance comparison of two feedaback modes, 3-1 and 2-2 are done in terms of probability of retransmission, MCS hitting probability and throughput.By analyzing the performance of these system, the 2-2 feedback mode is comparatively lower probability of retransmission. By using these models it also reduces the feedback information, thereby it reduces the overhead it costs the system degradation. For reducing the feedback information it uses the codebook, it contain all information about channel state information and channel gain. From these codebook user select the best channel quality information for mode 3-1 and best two channel quality information for mode 2-2. By using codebook mechanisms with feedback mechanisms it reduces the overhead and also increases the performace of the system.

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