

# LOW COMPLEXITY CHANNEL ESTIMATION USING RB AND RBG ALGORITHMS

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**Abstract:** In order to transfer a signal from BS to MS we use downlink communications based on Orthogonal Frequency Division Multiplexing (OFDM). Transmission is effective with the Long Term Evolution(LTE) operating in Frequency Division Duplex (FDD) mode. Pilot symbols can be used for channel state information. MU-MIMO enables the system to target different streams to different users. MIMO-OFDM system provides increased capacity but the bottleneck to it is estimation of CSI. Feedback of channel state information to the BS may be difficult, we consider two channel estimation algorithms, denoted as Resource Block (RB) and Resource Block Group (RBG). Two algorithms assumed the channel as constant over multiples of the fundamental LTE block which is composed of 12 subcarriers in each slot, known as Physical Resource Block (PRB). This leads to saving of feedback size for precoding purposes, with minimal BER performance loss.

**INDEX TERMS-** Frequency Division Duplexing(FDD), Resource Block(RB), Resource Block Group(RBG), MIMO - OFDM

## 1. INTRODUCTION

With the increasing population, the demand for higher data rates has increased. In order to cope with this requirement, a fifth generation cellular network(5G) is needed. The main objective of the 5G is to improve user spectral efficiency by MIMO and no. of antennas at Base Station(BS). Multiple Input Multiple Output(MIMO) is the most attracting techniques because of its significant data and coverage area without the use of additional bandwidth. Orthogonal Frequency Division Multiplexing(OFDM) is a modulation technique in which there are no. of subcarriers.

In OFDM, one data stream will be divided in to multiple sub streams and allocated to different frequencies in order to transfer them from transmitter to receiver. In OFDM, both transmitter and receiver have to be in linear and the sub carriers are orthogonal to each other in order to reduce the crosstalk and interference. Frequency Division Duplexing(FDD) operates OFDM called effective transmission. FDD is a technique of communication in which the connected people communicate each other in both directions because FDD uses different frequency bands for both downlink and uplink. So, the signals do not interfere while we sending and receiving them. In FDD, it is challenging to acquire downlink channels because the Base Station antennas are proportional to the channel parameters.

Here we are using Long Term Evolution(LTE) downlink frame which composed of a block of 12 subcarriers and called as Physical Resource Block(PRB) which consists of a smallest time-frequency element called Resource Elements(REs). With the use of Resource Block(RB) and Resource Block Group(RBG) we can easily estimate a low complexity channel in which the signal can be easily processed and transferred to the receiver. And the Bit Error Rate(BER) is minimal and Signal to Noise ratio is high.

## 2. LITERATURE SURVEY

### Channel Estimation Techniques in MIMO-OFDM LTE Systems:

The channel Estimation techniques help us to find low complexity channel. There is an certainly increasing request for greater data transmission with the development of the very large scale integration (VLSI) technology. The multiple input multiple output-orthogonal frequency division multiplexing (MIMO-OFDM) systems are used to achieve these requirements because of their unique properties such as great shadowy efficiency, extent data rate and resistance towards different propagation. MIMO-OFDM systems are finding their applications in the current wireless communication systems like IEEE 802.11n, 4G and LTE. They also offer dependable communication with the expanded coverage area. The bottleneck to the MIMO-OFDM systems is the evaluation of the channel state information (CSI). This can be rated with the help of any one of the Training Based, Semiblind and Blind Channel estimation algorithms. This paper presents so many channel estimation techniques, most usable techniques and their effective discharge in MIMO-OFDM for present wireless LTE systems.

**Low complexity downlink channel estimation for LTE systems:**

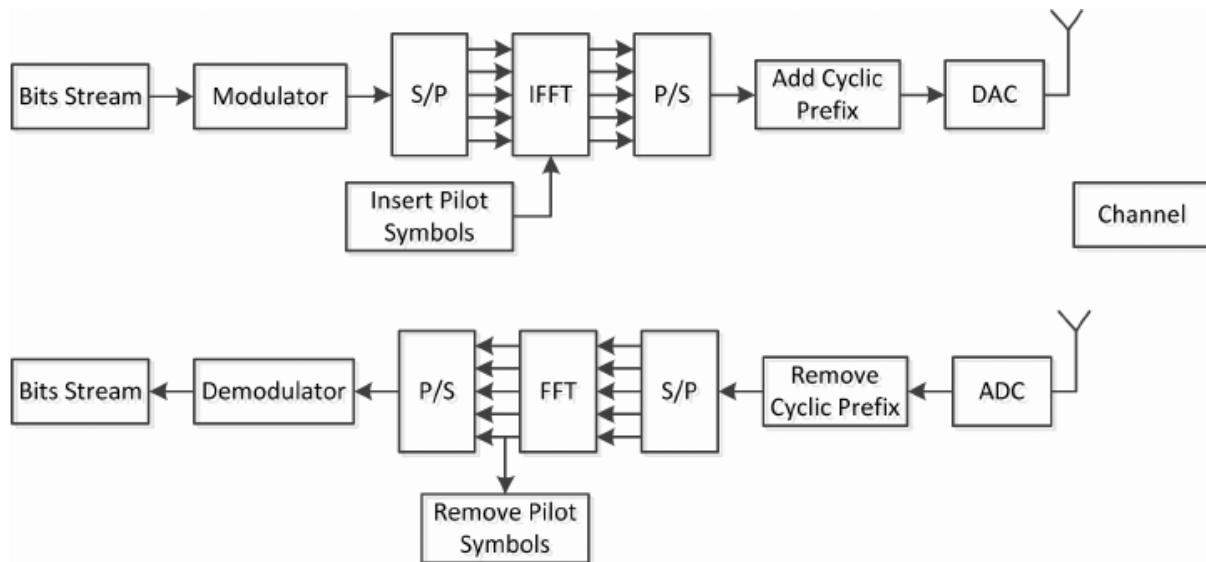
The 3rd engendering association project (3GPP) long term evolution (LTE) is outlined for large speed data rate, extended spectral efficiency, better services, and smaller latency as well as high-magnitude voice support. LTE uses orthogonal frequency division multiplexing ingress (OFDMA) project for the downlink transmission and single carrier frequency division multiple ingress (SCFDMA)in uplink. LTE is used for lengthy duration communication. Main challenges for extreme application are efficient understanding of the inner receiver, for channel estimation (CE) and regularity. A new channel estimator is presented for an OFDMA system under the umbrella of the 3GPP LTE that can overcome the ill-conditioned least square (LS) problem. This channel approximation method wields enjoin of medium resources to perceived the unrevealed channel transfer function at not pilots sub carriers. Hence, the computational complexity can be reduced.

**A Joint Approach for Low-Complexity Channel Estimation in 5G Massive MIMO Systems:**

Conventional Minimum Mean Square Error (MMSE) observation is mostly used in wireless communications, however, it initiates matrix inversion and has a greater ciphering complexity. For massive Multiple-input Multiple-output (MIMO) systems, this observation complexity is very extent due to its large channel matrix dimension. Therefore, low-complexity observation technology has become a hot topic in the industry. Day by Day the population goes on extension. So, the fifth generation network can be used in order to furnish spectral efficiency and extended data rates with large coverage area. Pointing out the awkwardness of high calculated complexity of the massive MIMO channel estimation, a squat-complexity algorithmic rules for methodical channel estimation. The proposed algorithm is based on joint Singular Value Decomposition (SVD) and Iterative Least Square with Projection (SVD-ILSP) which conquers the drawback of finite sample data assumption of the covariance matrix in the given SVD-based semi-blind channel estimation scheme. Simulation results show that the preferred scheme can helpfully decrease the deviation, improve the channel estimation accuracy, lessen the impact of pilot taint and obtain correct CSI with low overhead and computational complexity.

**3. OFDM SYSTEM**

The basic block diagram of OFDM is shown in Figure 1 can be explained as follow: At first the given binary data undergoes through channel coding and guard band insertion followed by the



**Figure 1** Basic OFDM System

serial to parallel transmission. Next, the IFFT operation is performed on the data sub carriers in which source symbols can be converted from frequency domain to time domain and after that cyclic prefix is added. After that, it is transmitted through RF block. At receiver side the process is opposite to the transmitted side. Cyclic prefix is removed and followed by serial to parallel conversion. The FFT operation is performed which converts the symbols to frequency domain. And finally the demodulation of the signal is performed to get the original one.

#### 4. CHANNEL ESTIMATION

In order to transfer signal from base station to mobile station we have to estimate the channel between them. The channel parameters are provided by the channel state information. To estimate the channel, the base station will send some pilot symbols which are unique symbols and are known to each other. The channel state information will be fed back to the transmitter which is estimated at the receiver. There are three types of channel estimation:

1. Training based estimation
2. Blind channel estimation
3. Semi blind channel estimation

#### 5. EXISTING METHODS

##### ZERO FORCING

After the channel if we want to restore the signal, ZF equalizer made use of inverse of channel frequency response to received signal. Pseudo inverse(PI) matrix of channel matrix R is:

$$S = R^{-1} \text{ for } M = N$$

$$S = (H^H H)^{-1} H^H \text{ for } M \neq N$$

##### MMSE ESTIMATION

The MMSE estimator employs a second-order of a channel conditions in order to minimize the mean-square error and in which they are denoted by  $S_{gg}$ ,  $S_{HH}$ ,  $S_{YY}$ ,  $S_{g^Y}$  the cross covariance matrix between  $\bar{g}$  and  $\bar{Y}$ . Also denoted by  $\sigma_N^2$  the noise variance  $E\{|\bar{N}|^2\}$ . The derived equations of the channel vector and noise are given below:

$$S_{HH} = \underline{F} S_{gg} \underline{F}^H$$

$$S_{g^Y} = E\{\bar{g}(X \underline{F} \bar{g}) + \bar{N}^H\} = S_{gg} \underline{F}^H \underline{X}^H$$

$$S_{yy} = E\{\bar{Y} \bar{Y}^H\} = \underline{X} \underline{F} S_{gg} \underline{F}^H \underline{X}^H + \sigma_N^2 \underline{I}_N$$

Compared to LS estimator MMSE estimator have much better performance, especially in low SNR scenarios. MMSE is a common estimation of evaluation of estimator value. The disadvantage of MMSE estimator is its high computational complexity.

##### LMS ESTIMATION

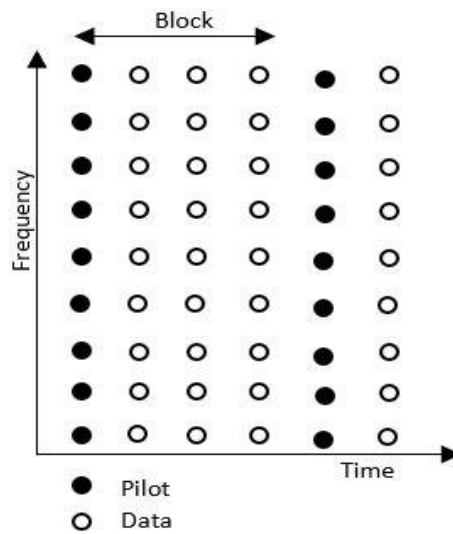
LMS are a type of adaptive filters which is used to imitate desired filters and used to produce difference between desired and actual signal. We can also write transmitted and received signals in the form of vector :

$$p[n] = [p[n,0], p[n,1], \dots, p[n,k-1]]$$

$$t[n] = [t[n,0], t[n,1], \dots, t[n,k-1]]$$

#### 6. PROPOSED METHODS

The Block type arrangement is shown in Figure 2. In Block type arrangement, the OFDM symbols have pilots at subcarriers and these are transmitted for channel estimation. This type arrangement is more suitable for frequency selective channels. A time-domain interpolation is performed in order to estimate a channel along the time axis by using these pilots.



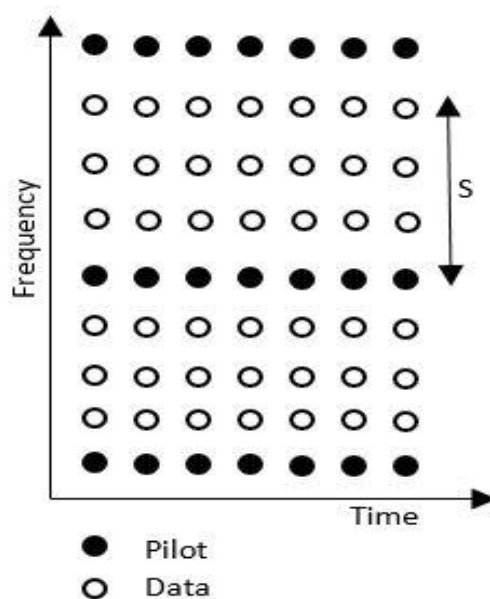
**Figure 2** Block type pilot arrangement

We have to keep an eye of the time differing medium and its features, the unique symbols must be worn and placed regularly as like the unity time is.

As the coherence time is given as inverse form of Doppler frequency, Doppler fin the channel. Because of this disadvantage, we support the multiple pilot tones at each time with data but with a specific subcarrier as shown in Figure 3.

In comb type pilot arrangement, the input signal consists of OFDM symbols in which each and every OFDM symbol has pilot tones. In order to estimate channel the channel, frequency domain interpolation is performed along the frequency axis.

Pilot signal evaluation and Channel evaluation are the divisions of the comb type pilot based channel estimation. The superiority and dominance of the comb-type pilot based channel estimation is, it have capability to trace the difference of the medium caused by the doppler frequency, and there is a let up in doppler effect and based on that there is an increase in symbol mobility.



**Figure 3** Comb type pilot arrangement

## RESOURCE BLOCK

A Resource Block is a smallest unit of resources. And this can be allocated to the users and the number of subcarriers that can be allocated per resource block for signals and channels is 12 subcarriers. The LTE downlink consists of 12 subcarriers in a slot, called as Physical Resource Block (PRB). The channel response for the full PRB is approximated with that observed one in a subcarrier of a PRB.

## RESOURCE ALLOCATION

Resource allocation in which the modulation symbols that have to be transmitted on each antenna port are taken and matched them to the available resource elements in the available resource blocks. But some or all of the resource elements in resource blocks may not be available for transport channel transmission as they may be used for the demodulation of the signals.

## RESOURCE BLOCK GROUP

The extension of Resource Block is called as Resource Block Group. And by averaging the estimation of channel over PRBs and using one value for all the subcarriers in that PRBs. RBG resembles the Resource Allocation Type 0 in LTE which is used to know how group of PRBs are allocated to users.

## 7. RESULTS

The actual medium is accumulated by the data symbols from both of the transmitter including a

unique symbols. Approximate medium which is obtained by using Resource Block and Resource Block Group is called the first approximated channel. We can estimate the inclusive channel estimation through the use of medium information, in all sub carriers with no pilot symbols.

Channel quality indicator(0-1)	0.8
Interference for DIR	55, 4, 24
Guard interval length	64
No. of Pilots	32
No. of data sub channels	224
No. of channel taps	4
User speed	4km/h
Modulation	64-QAM

Channel estimation is also measured based on the value of Bit Error Rate (BER). The greater the SNR the smaller is the BER. The bit error rate is defined as number of bit errors per unit time. System performance can also be monitored based on the channel capacity.

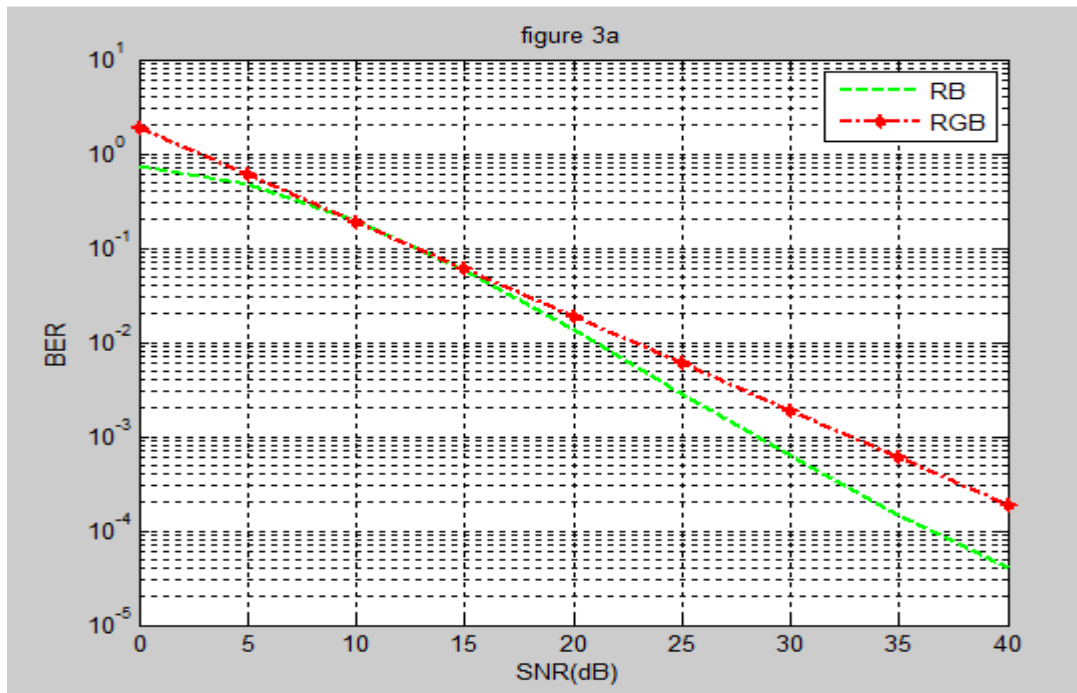
LTE downlink increases speed and capacity. The connection may last long. The signal can be processed easily while transmitting from transmitter to the receiver using Resource Block and Resource Block Group.

We compare the BER performance between the original channel system and estimated channel system. LTE is a most attracting technique and using LTE, the signal can be reached to the user and it can be processed easily and the connection may last long time with low interruption.

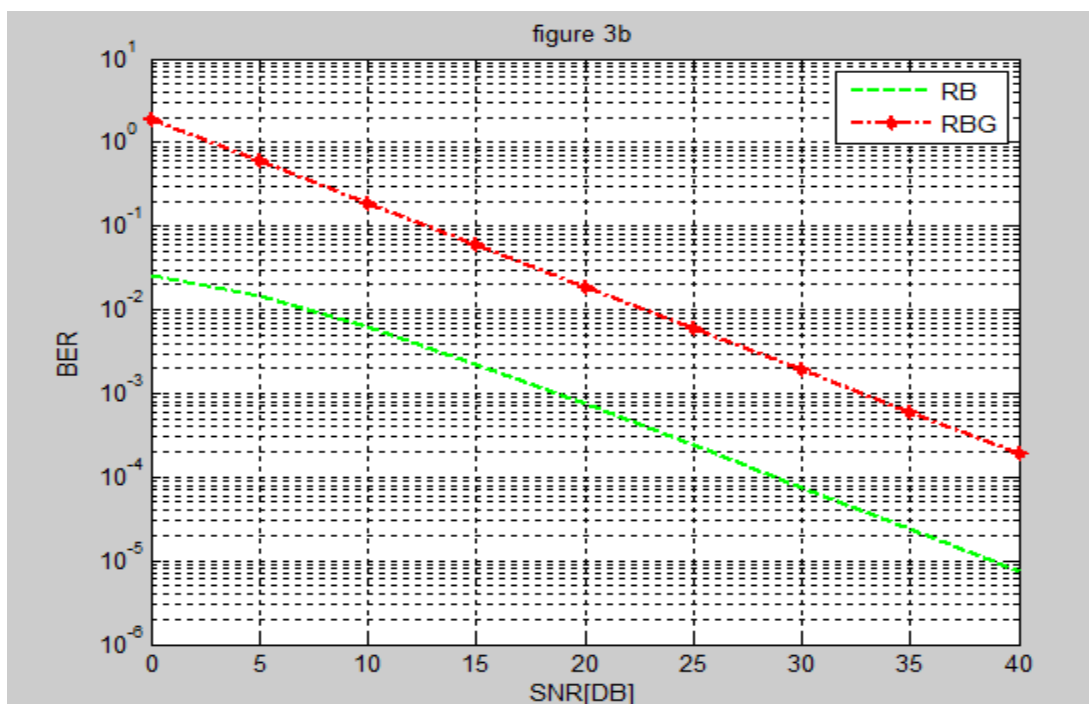
Using LTE which is a promising technology and which has designed to face growing demands of population we can have the required delay and low latency. The result of channel estimation is being affected by the SNR value.

One PRBs can have 12 subcarriers one by one which are equivalent to 180 kHz and so called as Resource Elements(REs) and are allocated to the users in order to process the signal easily. The amount of feedback to the transmitter from the receiver is easy using RB and RBG algorithm.

Larger the SNR value higher the accuracy of the estimation will be present. It relates to detection techniques and channel estimation selection techniques. The value of BER can be affected by the channel estimation value and while increasing SNR the BER decreases.



**Figure 4** BER as a function of SNR, the presented channel estimation algorithms are considered with MMSE equalizer and ZF precoder



**Figure 5** BER, as a function of SNR, the presented channel estimation algorithms are consider with MMSE equalizer and with RI precoder.



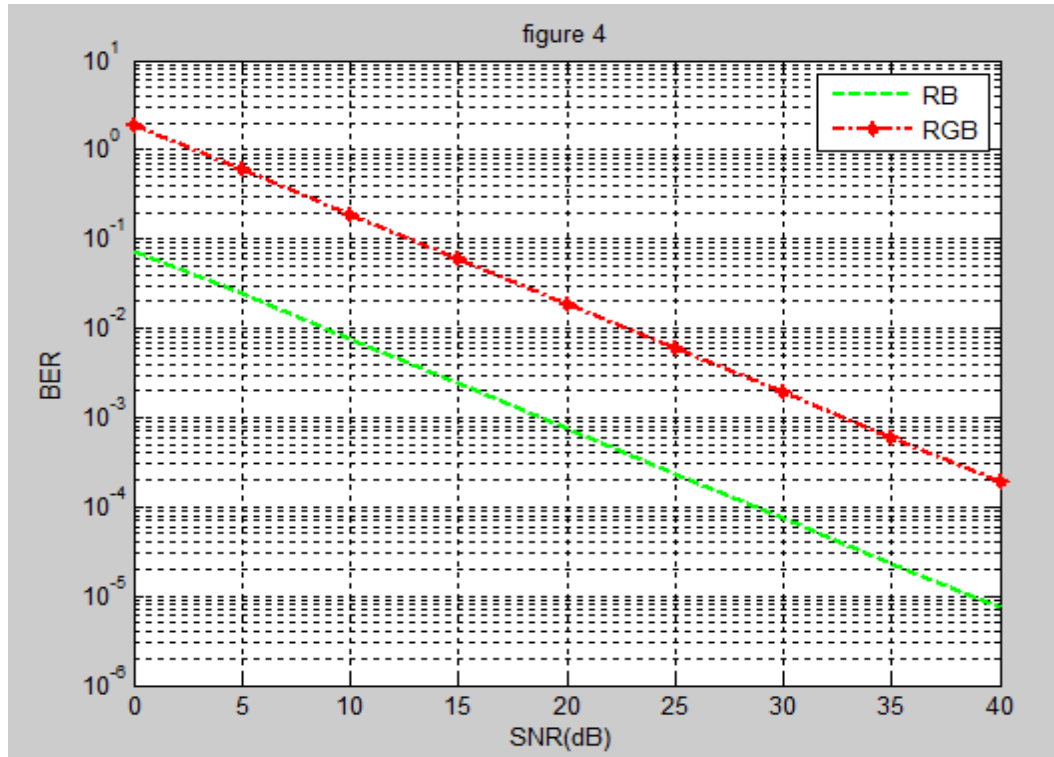


Figure 6 BER, as a function of SNR, considering MMSE equalizer, the presented precoder and the channel estimation algorithms.

## 8. CONCLUSION

Resource Block(RB) and Resource Block Group(RBG) algorithms provide best solution in terms of computational complexity as compared to Least Mean Square and MMSE algorithm for orthogonal frequency division multiplexing multi user MIMO communication between base station and mobile stations. Using LTE, the communication lasts long and speed increases. Because of these algorithms we can save the amount of feedback to the transmitter and minimal the BER.

## 9. FUTURE SCOPE

RB and RBG are the favourable choices for the most of the industries due to its unique features and less complexity. MIMO-OFDM provides high data rates without additional bandwidth and covers more area. Because of MIMO-OFDM, channel encryption methods can easily transfer the data with high security and speed because we can transfer both image and video simultaneously and signal can be processed easily without any loss.

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