An Improved Channel Estimation Method based on Jointly Preprocessing of Time-frequency Domain in TD-LTE System

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***Abstract*—As we know, LTE is the transition between the 3G and 4G and is also the global standard of 3.9G, which has improved and enhanced the air interface technology of 3G. LTE is characterized into two cases: LTE-FDD and LTE-TDD. Since LTE-TDD is researched dominantly in China, all the studies in this paper are discussed under the TD-LTE system. However, in the TDD system, the reciprocity is usually assumed since the uplink and the downlink work at the same frequency, that is to say, the estimated channel in uplink can be used to guide some downlink transmission, such as power allocation and so on. In order to estimate the uplink channel precisely, an appropriate estimation scheme with good performance is needed. In this paper, we have studied various channel estimation algorithms based on the characteristic pilot structure in uplink. And then an improved channel estimation method based on the jointly preprocessing in time-frequency domain is proposed. This method is mainly used in the following cases: the uplink channel is not estimated accurately via the successive pilot due to the interference and noise; the data processing will introduce delay and the user moves quickly, which will cause the estimated channel is not the real downlink channel. We further process the estimated channel both in time domain and in frequency domain. The final channel is used to design the beam forming vector, thus the performance of the system will be improved. Simulation results show that, the proposed method has improved the system performance in terms of bit error rate. .**

***Index Terms*—Link Budget; Preceding Scheme; SLNR; Interference; Iteration; BER Performance**

I. INTRODUCTION

Long Term Evolution (LTE) is the evolution of 3 G, proposed in the 3GPP conference in Toronto in 2004. LTE is not the 4 G technology with widespread misunderstanding, but the transition between the 3G and 4G, which is global standard of 3.9 G [1]. LTE has improved and enhanced the 3 G air interface technology, using OFDM and MIMO as unique standard of its wireless network evolution, which can provide downside under 326 Mbit/s and about 86 Mbit/s peak rate in the 20 MHz spectrum bandwidth [2]. Moreover, LTE has improved performance of the cell-edge user, increased the cell capacity and reduced the delay system. LTE is characterized into two cases: LTE-FDD and LTE-TDD. China mobile are promoting the development of TD-LTE at full tilt and all the studies in this paper are discussed under the TD-LTE system [3].

Since the cyclic prefix (CP) is introduced in OFDM which is the key technology of LTE, we can utilize frequency equalization to eliminate the multi-path interference at the receiver [4]. As we know, frequency equalization requires that the accurate frequency response is available on each subcarrier, therefore the channel need to be estimated before equalization and the accuracy of channel estimation will directly determine the performance of the receiver. In addition, in most cases, if channel information is available, the performance of the system will be promoted. In TD-LTE system, various preprocessing techniques in downlink based on the channel information, such as power allocation, pre-coding and so on, need to know the estimated channel information in uplink to be completed via the reciprocity between uplink and downlink. Usually, the accuracy of the channel will determine the performance of the system which utilizes these techniques [5].

Channel estimation is to estimate the wireless channel response from the transmitter to the receiver. Common channel estimation methods contain blind channel estimation and the channel estimation based on pilot signal. Although blind channel estimation needs not transmit pilot which can improve the data transmitting rate, it is necessary to collect a large number of data for ensuring the reliability [6, 7]. In TD-LTE system the pilot signal is continuous in the frequency domain. Therefore the estimated channel in the uplink holds the jump characteristic in amplitude and phase when the interference and noise exist. However, this paper

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proposes a new method called filter in frequency domain to smooth the jump between adjacent subcarriers [7].

TD-LTE can largely reduce the communication delay, increase user data rates, improved system capacity and coverage, and reduces operator costs, making it a major mobile operator of choice for building next-generation communications system standard. TD-LTE features a variety of advantages thanks to their use of advanced communications technologies, including OFDM, MIMO, adaptive modulation and coding (AMC) and hybrid automatic repeat request (HARQ) and so on. In the test personnel to TD-LTE communication system, when tested according to the different needs of different test cases written test plan, modify parameters associated with these technologies, and in the end of the test based on those parameters need to check the test results, it is in this brief introduction to TD-LTE systems involved in communications technology.

In this paper, the estimated channel in uplink will be used to calculate the beam forming vector in downlink. In the present some beam forming method, such as Zero-forcing (ZF) beam forming method, the Minimum Variance Distortionless Response (MVDR) beam forming method, the Minimum Mean Square Error (MMSE) and so on, all need to use the original channel information to realize beam forming.

TD-LTE system utilizes the estimated channel at present moment in uplink to compute the beam forming vector at the next moment in downlink, which is based on the assumption that the feedback delay between downlink and uplink is zero [8]. When the channel change slowly, this kind of practice is feasible. But in practice the receiver need to accomplish various signal processing technologies and the delay exists when the channel information is feedback to transmitter. Under the circumstances, if we use the estimated channel at current moment in uplink to compute the beam forming vector at the next moment in downlink, the error will be introduced due to the variation of channel. Therefore it is not very reasonable that we use the estimated channel at current moment in uplink to compute the beam forming vector at the next moment in downlink. The channel is caused to be vibrational as a result of the movement of the mobile station or other reasons, in this case, using such channel information for the beam-forming of downlink will introduce some degree of error, the bit error rate (BER) performance will decrease and the communication quality cannot be guaranteed [9]. Therefore we need to forecast the channel which is closer to actual situation.

Based on the advantage of the existing channel estimation technologies, we propose a new channel preprocessing scheme termed the improved channel estimation method based on the jointly preprocessing in time-frequency domain. Simulation results show that, the proposed channel preprocessing scheme has improved the system performance in BER compared with pioneering channel estimation technologies [10].

The reminder of this paper is organized as follows. In Section 2, we outline the system model of the channel estimation [11]. In Section 3 we describe the pioneering channel estimation technologies. In Section 4, we present an improved channel estimation method based on the jointly preprocessing in time-frequency domain. In section 5, we provide the simulation results and performance analysis, and Section 6 concludes the paper. Notations: $(\cdot)^H$, $(\cdot)^{-1}$, and E $(\cdot)$ denote, conjugate transpose, inverse, and expectation, respectively [12].

II. Related Works

A. The Basic Block Diagram of Modern Mobile Communication

The transmitting data goby channel encoding and interleaving is processed with SC-FDMA technology, and CP is added to it, the final signal is transmitted in the transmitter. Channel estimation utilizes the received pilot to estimate the frequency response of the channel. Therefore channel estimation results will directly affects the system performance. The receiver decomposes the data in inverse process accordingly. For the subcarrier k, let h denote the channel from the transmitter to receiver and x is the transmitting data. Figure 1 shows the basic block diagram of modern mobile communication base station [13]. The signal at the receiver is given by

$$y = hwx + n + s \tag{1}$$

where w is the beam forming vector, s denotes the sum of all interference terms and n is the additive white Gaussion noise with $E\left[nn^H\right] = \sigma^2$.

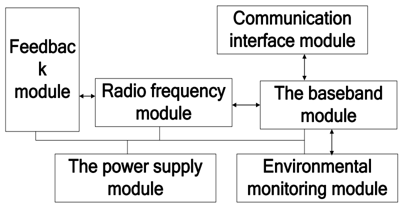

Figure 1. The basic block diagram of modern mobile communication base station

The mobile communication base station has experienced from analog to digital, from narrowband to broadband development sharp change, the system architecture with the evolution and development of the function of the system constant. At present, the base station of the latest generation of 3G mobile communication with multi-carrier, high-efficient pre-distortion digital power amplifier, a high performance HSDPA, open architecture features. The base station is in the form of the future, will undoubtedly toward functional macro base station, more powerful and integrated volume more portable, micro base station network more flexible distributed base station 3 direction; at the same time the base station in the framework, the evolution will be open, modular products. As the base function is stronger, the composition of the base station also at continuously perfect, but the basic functional modules of the base station from the digital communication are basically unchanged [14].

Software testing is to verify whether the difference between target design requirements, in accordance with the proposed to identify actual output and output theory exists to design, locating and correcting incorrect to reduce risk. However, only for the purpose of checking and correcting the software defects are not test, through the analysis of the abnormal output positioning reasons for this defect, can let testers find out the test rules and effective strategies, and improve the effectiveness and efficiency of test. This analysis can also detect deficiencies in the software development process, so that relevant personnel quickly to improve. Even if not detected any defect, test analysis can also provide reference for software quality evaluation [15-17].

According to (1), we can estimate the frequency response of channel using the pilot by

$$h = \frac{y}{x} \tag{2}$$

The channel gain on other symbols in one sub-frame can be obtained via the interpolation of the channel gain on the pilot subcarrier. The development of the communication technology of RF system require, which also contributed to the improvement and optimization of RF transceiver system architecture [18]. Put each new structure is a breakthrough of the previous theory, also caused new problems brought new advantage at the same time, people also gradually overcome these problems in promoting the system architecture evolution to update, better direction [19]. Of course the evolution direction is not change, namely, high reliability, low cost, low power, high integration and so. Undeniable, has a deep impact of the rapid development of integrated chip for RF system architecture evolution. In the same RF system, usually the receiver and transmitter is reciprocal symmetric architecture, this paper will select several typical architecture of receiver architecture appears in the evolution process as an example, to analyze the characteristics and differences of different RF system architecture [20].

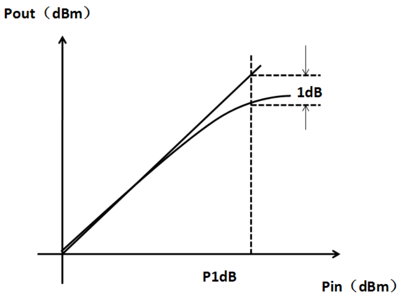

Figure 2. The power output of the 1dB compression point

The LMMSE channel estimation algorithm has good performance of channel estimation and can remove the effect of noise by using the statistical correlation of channel [21, 22]. However, the statistics of channel is hard to obtain and the complexity is large, therefore the availability of the LMMSE algorithm is poor. In most systems of opposite sign, so gain will system with input signal amplitude increases, usually gain dropped to define than the linear output power gain and low 1dB values for the power output of the 1dB compression point as shown in Figure 2.When the power is more than P1dB, the gain will decline rapidly and reach the maximum output power, the value is generally greater than that of P1dB 3dB-4dB. This is to say the 1dB compression point is larger, the dynamic range of linear larger RF system.

B. Various Channel Estimation Schemes

LTE protocol provides a specific pilot structure used for channel estimation for multiple antennas system. We can accomplish the channel estimation with the auxiliary of pilot. The DMRS (Demodulation Reference Signal) of PUSCH (Physical Uplink Shared Channel) in TD-LTE system is only transmitted on the frequency band where the UE (User Equipment) is transmitted; therefore the pilot length is restricted. For example in extreme cases, when the UE transmits PUSCH on only one RB (Resource Block), if DMRS using massive pilot patterns, the sequence's length is the frequency 12, or if using pectinate or other patterns, the sequence's length frequency is insufficient to 12. Since the pilot length determines the number of available pilot, the pilot length is not ought to be too little. Therefore uplink will utilize the massive pilot as depicted in Fig. 3.

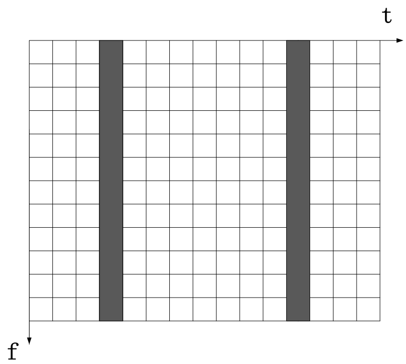

Figure 3. The pilot structure of uplink

Using such pilot pattern we can estimate the channel response on each subcarrier. The channel estimation of TD-LTE system is usually divided into two parts, one is the channel response estimation of the pilot subcarrier, where we mainly finish the corresponding processing on the pilot and eliminating the interference effects and finally obtain the channel response estimation of the pilot subcarrier; The other part is part of interpolation, through the interpolation we can get complete channel response estimation. However, there are several channel estimation schemes.

C. The LS Channel Estimation Algorithm

The least square estimation (LS) algorithm is one of the classical channel estimation algorithms.

According to the minimum variance criteria, the cost function is defined as:

$$J_{LS} = (Y_p - \hat{H}_p X_p)^H (Y_p - \hat{H}_p X_p) \tag{3}$$

where Y_p denotes the received signal on the pilot subcarriers, $\hat{H}_p$ refers to the channel response estimation on the pilot subcarriers and X_p is the transmitted pilot signal. Let J_{LS} in (3) is zero, from the equation (3), we calculate the $\hat{H}_p$ according to

$$H_P = \frac{Y_p}{X_p} = \frac{H_P X_p}{X_p} + \frac{N_p}{X_p} = H_P + \frac{N_p}{X_p} \quad (4)$$

where N_p is the noise and interference on the pilot subcarrier.

For this kind of channel estimation scheme, all operations can be accomplished in the frequency domain and the structure is very simple. Therefore this kind of channel estimation scheme is used widely. However, as expressed in (4), since the LS criterion does not consider the influence of the noise, the channel estimation results will be affected by noise seriously.

The MMSE channel estimation algorithm

In order to remove the effect of noise and improve the accuracy of channel estimation, the MMSE criterion is considered to design channel estimation algorithm. According to MMSE criteria, the cost function is defined as:

$$Jmmse = E[(H_P - H_P')*(H_P - H_P')] \quad (5)$$

Let M denote the number of pilot subcarrier and $Y_p = [Y_1, Y_1, ..., Y_M]^T$ denote the set of the received signal at all pilot subcarriers. Then $R_{YY} = E[Y_p Y_p^H]$ and $R_{HY} = E[H_p Y_p^H]$ are the self-correlation matrix of the received signal at each pilot subcarrier and the cross-correlation matrix of the received signal at each pilot subcarrier with the channel response. After deriving, the channel estimation based on MMSE criterion is:

$$\hat{H}_p = W^T Y_p = R_{HY} R_{YY}^{-1} Y_p \quad (6)$$

where $\hat{H}_p = [\hat{H}_1, \hat{H}_2, ..., \hat{H}_M]^T$, $W = [w_1, w_2, ..., w_M]^T$ is the tap of the filter.

Apparently, in order to estimate the channel response at the pilot subcarrier by using the received pilot signal via MMSE criterion, the cross-correlation matrix of the received signal at each pilot subcarrier and statistic characteristics of channel are needed to be available. However, in practice, the computing complexity is very large and the algorithm is hard to be carried out. Therefore some simple algorithms will be utilized, such as linear MMSE, which is proceeded only in frequency domain. The channel estimation can be expressed as

$$\hat{H}_{MMSE} = R_{HH}(R_{HH} + \sigma_n^2 (XX^H)^{-1})^{-1} \hat{H}_{LS} \quad (7)$$

where $\hat{H}_{LS}$ is the result of the LS algorithm, σ_n^2 is the variance of the additive white Gaussion noise and $R_{HH} = E[HH^H]$ is the self-correlation matrix of channel.

From the expression (7), we know that the LMMSE channel estimation algorithm is based on the LS channel estimation algorithm.

III. Proposed Scheme

In TD-LTE system, since time differences exist between uplink and downlink, transmission channel downlink information of uplink and downlink is not exactly the same. Under the circumstances, if we use the current estimated channel information to design the beam forming vector at next time, the error will be introduced due to the channel change. In this paper, a time prediction scheme of channel is proposed. In addition, the channel information on each subcarrier can be directly estimated without interpolation because of the inherent successive pilot structure in uplink and the estimated channel information on each subcarrier is accurate. When noise and interference exist, the channel information of adjacent subcarriers is relatively independent and the jump between adjacent subcarriers will be introduced. However, TD-LTE system utilize SCME (Spatial Channel Model Extended) channel to model the system and the SCME channel changes slowly, that is to say, the channel information between adjacent subcarriers is highly correlated. Therefore the jump characteristic and slow degeneration of adjacent subcarriers are contradictory. In this paper, we will use some smooth processing technologies to smooth the channel through the prediction in time domain to improve the system performance.

To accomplish our proposed channel estimation method by utilizing the prediction in time domain and sooth processing, the following steps will be included.

A. Using the Received Pilot Signal to Estimate the Uplink Channel

According to TD-LTE protocol, uplink pilot pattern adopts the massive pattern, that is, the pilot signal is inserted on each subcarrier in the middle symbol of each time slot. Therefore the channel information on each subcarrier can be estimated at the receiver. This kind of pilot pattern is suitable for frequency selective channel. For simplicity, the LS channel estimation algorithm is considered in this paper. By using pilot signal, we can estimate the channel response on each subcarrier. For one time slot, the estimated channel information can be expressed as:

$$\mathbf{H} = [H_1, H_2, ..., H_N]^T \quad (8)$$

where N is the number of the subcarriers and H_k is the channel information on the k th subcarrier.

B. Predicting the Estimated Channel in Time Domain

Considering the slow change characteristics of the space channel in time domain, the downlink and uplink are time division duplex in TD-LTE system. Compared with the FDD system, TDD system is more flexible to configure proportion downlink and uplink resources, in order to support different business types. No matter which kinds of configuration, they all have a common characteristic that the downlink transmission is the time division, interlock together. Channel in adjacent time slot is always relevant. Considering the correlation we use the channel information at current time to predict the channel information at the next moment.

The transmission time interval (TTI) is 1 ms, containing a sub frame (2 slot). The pilot is on the middle SC-FDMA symbol at each time slot, each sub-carrier have guided frequency, which covers the whole bandwidth. Then through the channel estimation, we will get the channel information of two slots in frequency domain:

$$\begin{aligned}\mathbf{H_1} &= [H_{11}, H_{12}, ..., H_{1N}]^T \\ \mathbf{H}_2 &= [H_{21}, H_{22}, ..., H_{2N}]^T\end{aligned} \quad (9)$$

In order to get the channel information of next frame, we make the forecast on each sub-carrier get the channel information at current moment. The prediction contains many ways. If the channel changes slowly, the effect of the forecast has inconspicuous effect; but if channel changes fast, the choice of prediction is especially important. Fig. 3 compares the system performance under the circumstances that the time delay between uplink and downlink exist or not. Fig. 1 show that time delay has certain effects on the bit error rate (BER) performance of the system, the higher signal-to-noise ratio (SNR) is, the more obvious this effect is. Therefore it is necessary to predict the estimated channel information.

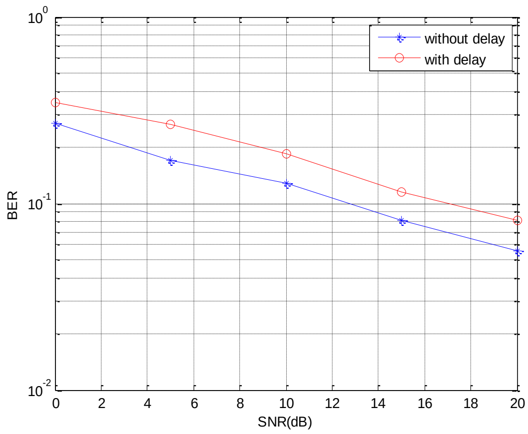

Figure 4. The comparison of system performance with delay and without delay

Since the SCME channel in our system changes slowly, the prediction in this paper makes a fine adjustment for the estimated channel. When the estimated channel in one sub frame is known, for the k th subcarrier, the channel information of the next sub frame is predicted linearly:

$$\begin{cases} H_{3k} = (\alpha_1 H_{1k} + \beta_1 H_{2k}) / (\alpha_1 + \beta_1) \\ H_{4k} = (\alpha_2 H_{1k} + \beta_2 H_{2k}) / (\alpha_2 + \beta_2) \end{cases} \quad (10)$$

where $\alpha_1, \alpha_2, \beta_1, \beta_2$ are preset parameters. Based on certain amount of experiments, $\alpha_1, \alpha_2, \beta_1, \beta_2$ are chosen as the following values which can achieve better effects.

$$\begin{cases} \alpha_1 = 1, \ \ \beta_1 = \dfrac{SNR}{20} * 0.1 \\ \alpha_2 = \dfrac{SNR}{20} * 0.1, \ \ \beta_2 = 1 \end{cases} \quad (11)$$

C. Smooth the Predicted Channel in Frequency Domain

By using the massive pilot pattern in uplink, the channel information on each subcarrier can be directly estimated without interpolation and the estimated channel information on each subcarrier is accurate. When noise and interference exist, the channel information of adjacent subcarriers is relatively independent and the jump between adjacent subcarriers will be introduced. The correlation of the real channel is destroyed. If the estimated channel is directly used for the designing the beam forming vector, the system performance will decrease.

However, the above-mentioned prediction contributes a fine adjustment to the estimated channel has improved the system performance weakly, which do not change the jump in terms of magnitude and phase caused by successive pilot structure and therefore we need make some processing in frequency domain. Due to the correlation of the adjacent subcarriers, we can sooth the channel in frequency domain. Smooth's role is to remove or weaken the high frequency components of channel estimation, and its essence is the low pass filtering, that is, through the low pass filtering, the high frequency component is removed.

There are many kinds of smooth, we list the main two ways: arithmetic average method and low-pass with window method. For arithmetic average method, many adjacent subcarriers are considered; we use the average value of these subcarriers to replace the original sub-carrier channel coefficient. value here refers to take a subcarrier, and it before and after the adjacent several subcarrier channel coefficient, in fact the average operation plays a smooth role, each sub-carrier will consider its adjacent subcarriers and the high coefficients is weakened. For the low-pass with window method, using low-pass filter for channel information in frequency domain filtering is another smooth way. Here we use digital filters and the design of the filter contains the following steps: designate the expected frequency response of the filter through the Fourier inverse transform; select a window function which meet band pass or attenuation index, and then determine the order of filter using the relationship between the length of filter and transitional bandwidth; get the filter coefficients from the selected the window function.

In this paper, the simple arithmetic average method is considered and the average with L subcarriers is considered. The predicted channel is $\mathbf{HH} = [HH_1, HH_2, ..., HH_{N_c}]^T$ (N_c is the number of subcarriers). For the k th subcarrier, the channel through smooth is

$$H_k{}' = \begin{cases} (H_{k-\frac{L-1}{2}} + \ldots + H_{k-1} + H_k + H_{k+1} + \ldots + H_{k+\frac{L-1}{2}})/L, \; k = \frac{L+1}{2}, \ldots, N_c - \frac{L+1}{2} \\ H_k \end{cases}$$

Compared the magnitude and phase after smooth with original channel

The upper two figures are the magnitude of smoothed channel and original channel, and the under two figures are the phase of smoothed channel and original channel. Obviously, the channel through smooth processing is smooth. Through such a simple way, we would weaken the influence of the noise and interference in channel estimation and prediction. The magnitude and phase of channel information diagram after smooth are smoother obviously than the corresponding quantities of original channel, which is more in line with the real channel characteristics. And if the smooth scheme is used for designing the beam forming vector, the system performance will be better.

The low-pass with window method is also considered in this paper. The window functions mainly contain cosine window, Hamming window and Kaiser window etc.

D. Use the Optimized Channel to Compute the Beam Forming Vector

The optimized channel through above-mentioned prediction and smooth is used to compute the beam forming vector. There are many kinds of beam forming methods, such as ZF, MMSE and so on.

IV. Simulation Results

In this section, we provide the simulation results to demonstrate the effectiveness of our proposals for the improved channel estimation method based on the jointly preprocessing in time-frequency domain. We assume the channel is a quasi-static flat fading channel in our system. Without loss of generality, we consider the BERas the performance measurement to verify the advantage of our scheme in this paper.

In our TD-LTE system, the number of antennas at base station is 4 and the user equipment (UE) is equipped a single antenna and the antenna distance is 0.5λ. The smooth mean is the average with 5 subcarriers and ZF is chosen as the beam forming method. With 3km/h of UE speed, we compare the BER performance between the beam forming method with the proposed scheme in this paper and the beam forming method without the proposed scheme in Fig. 5.

According to the simulation results, the proposed estimation method based on the jointly preprocessing in time-frequency domain in this paper has improved the system performance in terms of BER. That is to say, the proposed estimation scheme based on the jointly preprocessing in time-frequency domain in this paper is better than the original scheme.

However, the proposed estimation method based on the jointly preprocessing in time-frequency domain in this paper can be used to design beam forming vector of the MMSE and MVDR beam forming or other beam forming schemes. Systematic test on the receiver, is whether the receiver RF link design is necessary for successful, more important is the important source of further improvement design. The design of the test is divided into two parts: LNA single board test and whole test. In order to separate to test the noise coefficient and gain of low noise amplifier, the design will be specially low noise amplifier of independent board, Figure 6 is a low noise amplifier board testing environment.

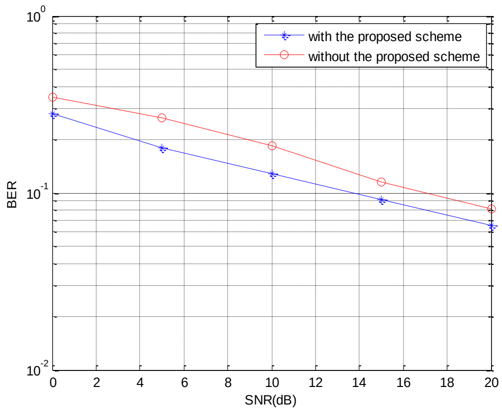

Figure 5. The comparison between the system without and with the proposed scheme

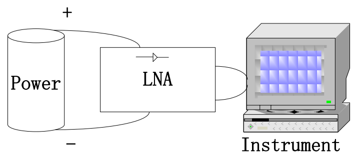

Figure 6. The low noise amplifier board testing environment

In the receiver system is complete, the design of the final output board should provide analog input ADC, after ADC sampling by FPGA analysis to assess the quality of signal, data and then, determine the performance of receiver. In view of this, the output signal now through the fly line will receive link RF unit to the evaluation board ADS6445 evaluation board, analog to digital converter on the input signal to digital signal to PC, PC to analyze the data through dedicated software.

The present communication industry concern LTE as the research object, using 3GPP for the LTE specification and requirements as the basis, combined with the master the RF knowledge tempted to realize RF circuit of TD-LTE base station receiver. Adhere to the theory research and analysis to guide the engineering practice in the design process, through the engineering practice to deepen understanding and cognition theory. In this paper, base station system and RF system structure is introduced as the breakthrough point, discuss several receiver structures for mainstream, and select zero if architecture design direction as the. Then, the related protocol with 3GPP extracted from the RF characteristics of TD-LTE base station receiver characteristic. Then, based on the

RF characteristics quantitatively calculate a specific radio frequency index TD-LTE base station receiver, combined with ADS2008 link simulation control these RF index to each function module of the specific circuit. Then, in strict accordance with the circuit module of the requirement for selection and circuit design, and create physical.

Affected by the broadband mobile networks, IP trend, TD-LTE system is designed for the whole IP network to provide better service based on network communication, it and traditional cellular mobile wide area network, broadband wireless access metropolitan area network, wireless transmission network and the traditional fixed access network and access based on the same IP core network, realization of seamless connection service. And relative to the 3G communication system simplifies the network architecture, a flat structure.TD-LTE air interface protocol, including the physical layer (PHY), media access control (MAC) layer, the radio link control (RLC) layer, data aggregation protocol (PDCP) layer and the radio resource control (RRC) layer. Control surface air interface protocol stack of TD-LTE system and user plane respectively, as shown in Figure 7.

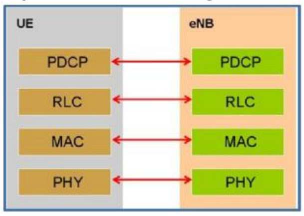

Figure 7. Control surface air interface protocol stack of TD-LTE system

TD-LTE communication protocol stack is usually divided into 3 layers. The PHY layer is often referred to as the layer 1 (L1); PDCP, RLC and MAC layer is often referred to as layer 2 (L2); non access stratum (NAS) and the RRC layer is often referred to as layer 3 (L3).TD-LTE system information is encapsulated into a master information block (MIB) and multiple system information block (SIB), associated with the various functions of the system parameters are stored in MIB, which is an important information for the UE initial access, usually including the use of frequent parameter; SIB1 included with the district selection related parameters, including system information block scheduling information other; SIB2 includes channel information related to sharing; SIB3-SIB11 contains frequency, frequency, wireless access technology (RAT) between the cell reselection parameters, earthquake and tsunami warning system and other related.

The RRC connection control including RRC connection establishment, retention and release, safety management and data radio bearer (DRB) to establish, modify and release. UE RRC connection state decide the process and the operation of the implementation of the access layer, the RRC state has two kinds: RRC idle state and the RRC connection state. In the RRC idle state: UE will monitor the paging channel, check whether there is a call; monitor the broadcast channel, in order to obtain system information; specific discontinuous reception; implementing cell selection or reselection. In the RRC connection state: to interact with the network data; reporting cache state and the channel quality can be controlled by eNB; cell switching. RRC connection establishment initiated by UE, eNB detects the connection establishment request after the corresponding configuration and return, the specific process is shown in Figure 8.

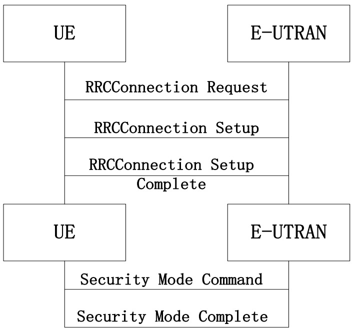

Figure 8. The connection establishment request after the corresponding configuration and return, the specific process

In the RRC idle state of LTE system under the mobility control refers to the UE perform cell reselection. Cell reselection on each frequency corresponding to the corresponding priority, and the priority given by the system information, the frequency of cell reselection according to these equal, then reordered according to the channel quality residential. In the RRC system connection, LTE mobility control for cell switching of E-UTRAN execution state. E-UTRAN chooses to receive cell switching to UE, to maintain the link connection. E-UTRAN measurement report requires UE to submit candidate receiving district before switching; because UE is always connected with a small, therefore the handoff in LTE is a hard handoff.

In the area of the selection process, UE estimates of the support RAT, support carrier, and find out the strongest signal from the cells of the. UE choose a good plot, in order to cell reselection, cell reselection according to the absolute priority of each plot, UE channel quality. The amount of sorting, then UE test whether target cell can access. If there is more than one candidate, UE District second ranking. If the service area of the order of Rs, the cells adjacent to the order of Rn, once an adjacent cell sorting than the service area, and maintain a certain time, then UE for the small cell reselection purposes.

V. Conclusion

In this contribution, LTE is considered as a considerably promising technology for the next generation mobile communication system. Since China mobile are promoting the development of TD-LTE at full tilt, we consider the TDD mode of LTE. However, the TD-LTE system is also an OFDM system and frequency equalization requires that the accurate frequency response is available on each subcarrier. In addition, various preprocessing techniques based on the channel information in downlink need know the estimated channel information in uplink which can be completed via the reciprocity between uplink and downlink.

Therefore the channel estimation is necessary in practical application.

In TD-LTE system, since time differences exist between uplink and downlink, transmission channel downlink information of uplink is not exactly the same with downlink. Under the circumstances, if we use the estimated channel information at current time to design the beam forming vector at next time, the error will be introduced due to the channel variability. In this paper, a prediction scheme of channel is proposed in time domain.

In addition, the channel information on each subcarrier can be directly estimated without interpolation because of the inherent successive pilot structure in uplink of TD-LTE system and the estimated channel information on each subcarrier will be accurate. When noise and interference exist, the channel information of adjacent subcarriers is relatively independent and the jump between adjacent subcarriers will be introduced. However, TD-LTE system utilize SCME channel to model the system and the SCME channel changes slowly, that is to say, the channel information between adjacent subcarriers is highly correlated. Therefore the jump characteristic and slow degeneration of adjacent subcarriers are contradictory. In order to solve the contradiction, in this paper, we will use some smooth processing technologies to smooth the channel through the prediction in time domain to improve the system performance.

In this paper we propose the estimation method based on the jointly preprocessing in time-frequency domain which outperforms the original channel estimation scheme.

REFERENCES

[1] 3GPP TS 36. 300, “Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved UTRA (E-UTRA). 2008.

[2] L Tong, G Xu, B Hassibi, and T Kailath, “Blind channel estimation based on second-order statistics: a frequency-domain approach”, *IEEE Trans. Inform. Theory*, vol. 41, pp. 329-334, 1995.

[3] Y Zhao, A Huang, “A novel channel estimation methods for OFDM mobile communication systems based on pilot signals and transform domain processing”, *in Pro. IEEE 47th Vehicular Technology Conference*, pp. 2089-2093, 1997.

[4] Theodore S. Rappaport etc. “Wireless Communications Principles and Practice.” *Publishing House of Electronics Industry*, 2003.

[5] Sinern Estimation Coleri, MustafaErgen, AnujPuri, Ahmad Bahai, “A Study of Channel in OFDM Systems”, *IEEE VTC, Vancouver, Canada. September*, 2002.

[6] D. B. Van, O. Edfors, and M. Sandle, “On channel estimation in OFDM systems”, *Proc. IEEE Vehic. Tech. Conf*, pp. 815-819, 1999.

[7] H. Landau, H. O.. Prolatespheriodal wave functions, “Fourier analysis and uncertainty-III: The dimension of the space of essentially time and band-limited signal”, *Bell Syst. Tech.* pp. 41-44, 2002.

[8] Bingyang Wu; Shixin Cheng; Ming Chen; Haifeng Wang. “Analysis of decision aided channel estimation in clipped OFDM”, *Vehicular Technology Conference, VTC-2005-Fall*, pp. 1030-1033, 2005.

[9] EffridedDustin, KeffRasjka, John Paul, “Automated Software Testing Introduction, Management, and Performance”, *Addison-Wesley* 2002.

[10] G. Patel, S. Dennett. “The 3GPP and 3GPP2 Movements Toward an All-IP Mobile Network”, *IEEE Personal Communications*, vol. 7, no. 4, pp. 66-64, 2002.

[11] Chernak Y. “Validating and improving test-case effectiveness”, *IEEE Software*, vol. 18, no. 1, pp. 81-86, 2001.

[12] QinqunFeng, Zhang Wuguang, Peng Yan, “Research on software testing tool based on Internet”, *Computer applications and software*, vol. 23, pp. 133-135, 2006.

[13] poolBaoyong, Yu Zhiping stone, “a review of. CMOS RF integrated circuit analysis and design”, vol. 32, pp. 31-35, 2007.

[14] Li Genqiang, Kuang Wang, Wen Zhi-cheng, “RF and wireless technology”, *Beijing: Electronic Industry*, vol. 12.. pp. 13-15, 2009.

[15] Cao Peng, Qi Wei, “Broadband wireless communication transceiver technology”, *Beijing: mechanical industry*, vol. 80, pp. 33-35, 2012.

[16] Ozaki, K.; Tomitsuka, K.; Okazaki, A.; Sano, H.; Kubo, H., "Channel estimation technique for OFDM systems spread by chirp sequences", *2012 IEEE 23rd International Symposium on Personal Indoor and Mobile Radio Communications (PIMRC)*, pp. 2125-2130, 2012.

[17] Vinogradova, J.; Sarmadi, N.; Pesavento, M, "Subspace-based semiblind channel estimation method for fast fading orthogonally coded MIMO-OFDM systems ", *2011 4th IEEE International Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP)*, pp. 153-156, 2011.

[18] M. Sadek, A. Tarighat, A. H. Sayed, “A Leakage-based Precoding Scheme for Downlink multi-user MIMO Channels”, *IEEE Transactions on Wireless Communications*, vol. 26, no. 8, pp. 1505-1515, 2008.

[19] A. Tarighat, M. Sadek, A. H. Sayed, “A multi User Beamforming Scheme for Downlink MIMO Channels based on Maximizing Signal-to-Leakage Ratios”, *IEEE International Conference on Acoustics, Speech, and Signal Processing*, pp. 1129-1132, 2005.

[20] J. van de Beek, O. Edfors, M. Sandell, S. Wilson, P. Borjesson, “On Channel Estimation in OFDM System”, *in Proceedings of the IEEE Vehicular Technology Conference*, pp. 815-819, 1995.

[21] K. Wong, R. Cheng, K. B. Letaeif, R. D. Murch, “Adaptive antennas at the mobile and base stations in an OFDM/TDMA system”, *IEEE Transactions on Communications*, vol. 49, no. 1, pp. 195-206, 2001.

[22] M. Sadek, A. Tarighat, A. H. Sayed, “Active Antenna Selection in multi-user MIMO Communications, ” *IEEE Transactions on Signal Processing*, vol. 55, no. 4, pp. 1498-1510, 2007.