International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 8, August - 2014

Performance Analysis of HC-CDMA for LTE Applications

K. Venkata Sivasai
Department of ECE,
Vaagdevi College of Engineering,

K. Kishan Rao
Department of ECE,
Vaagdevi College of Engineering,

M. Shashidhar
Department of ECE,
Vaagdevi College of Engineering,

N. V. Maruthi Sagar
Department of ECE,
Vikas College of engineering and Technology

***Abstract:* - In this paper, we propose to improve the performance of the channel estimation for LTE Downlink systems under the effect of the channel length. As LTE Downlink system is a Hybrid CDMA based system. LTE system mobility requirements are optimized for low terminal speed, 0-15 km/h, nevertheless mobile terminal speeds up to 350 km/h where slight degradation of performance is allowed. For cell sizes up to 5 km LTE can provide optimum performance meeting spectrum efficiency and mobility requirements, in the high-speed wireless communication systems, code division multiple access (CDMA) is an efficient technique for interference in the frequency-selective fading channels. In this letter, we combine the *hybrid carrier* (HC) scheme with CDMA and frequency domain linear equalization. The proposed system can not only provide the compatibility with single carrier (SC) CDMA and multicarrier(MC) CDMA systems, but also achieve a smooth and seamless transition between the two. The proposed system can switch to single carrier or multi-carrier scheme under the specific conditions. Moreover, HC-CDMA outperforms SC-CDMA and MC-CDMA systems over the frequency-selective fading channel and single frequency jamming channel.**

***Keywords:* LTE, Hybrid CDMA, HSPA, channel estimation and QAM.**

I. INTRODUCTION

Due the increasing demand for higher data rates for wireless communication systemsand the growth of mobile data transfer usage, the wireless communication area has gained significant attraction for mobile researches and industries worldwide.Mobile broadband is becoming reality and according to [1] out of theestimated 1.8 billion people, who will have broadband by 2012, some two thirdwill be mobile broadband customers and the majority will be served by HSPA(High Speed Packet Access) and LTE (Long Term Evolution). The key features of LTE are described below according to [2], [3] and [4]. The goal is to provide a high data rate, low latency and a packet optimized radio technology which supports flexible bandwidth deployment. The targets for downlink peak data rate requirements are 100 Mbit/s and 50 Mbit/s for uplink, when 20 MHz spectrum is allocated.

A promising technique to overcome the channel frequency selectivity is direct sequence spread spectrum (DSSS) or code division multiple access (CDMA), and it has been widely used in existing systems [5]. In view of the carrier scheme, there are mainly two approaches in CDMA systems—single carrier CDMA (SC-CDMA) and multi-carrier CDMA (MC-CDMA) [2].In SC-CDMA system time spreading is adopted, and each data symbol occupies the whole bandwidth. While in MCCDMA, the data symbols after spreading are modulated in different sub-carriers, and it can be understood that spreading is applied in frequency domain. Compared to SC-CDMA system, MC-CDMA system has a higher spectrum efficiency and flexibility [7], thus, it has achieved more attention in recent years [6], [8]. In MC-CDMA system, frequency domain equalization (FDE) is usually adopted to resist the channel frequency selectivity [6]. And in order to improve the system performance further, the research of MC-CDMA is extended to a wireless communication system employing Alamouti space-time block coding [8]. However, problems such as high peak to average power ratio (PAPR), which does not exist in SC-CDMA system, are great challenges to the multi-carrier scheme [5].

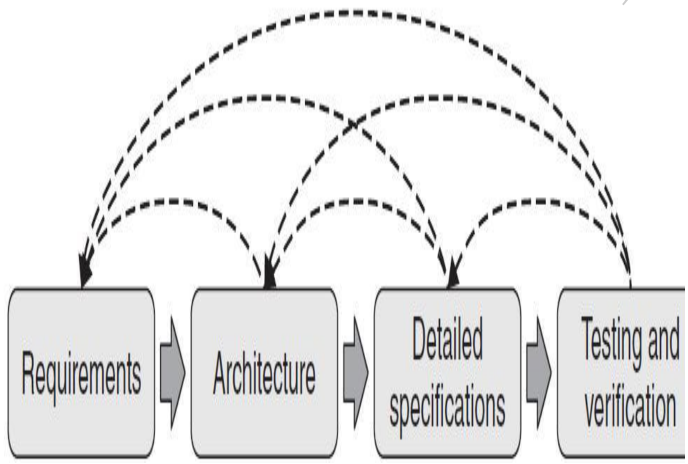
Convergence of the existing techniques in a common platform will be a main feature for future wireless systems. And there is also a thriving need to develop integrated mobile terminals [9]. In order to solve the compatibility issue with existing systems, [10] proposed a hybrid carrier (HC) communication system based on the weighted-type fractional Fourier transform (WFRFT). The HC scheme integrates MC and SC to achieve a more even time-frequency distribution of signal energy, and it is thought to have the potential superiority over the selective fading channels compared to the traditional SC and MC schemes. In [10] bit error ratio (BER) performance is also discussed in the simplified fading channel, and the HC system

outperforms SC and MC. In the aforementioned researches, the channel conditions are simple and the analysis of interference is not sufficient enough.
We propose a HC-CDMA communication system for LTE with the CDMA technique. Spreading is applied in a certain fractional domain, and the HC characteristic of SC and MC integration is achieved by LTE. At the receiver frequency domain equalization can further resist the channel fading and improve the system performance. Because of unitary property, the data after equalization can be transformed to the corresponding fractional domain, in which despreading and demodulation are utilized. In SC-CDMA or MC-CDMA system, the data symbol is spread in either time or frequency domain. By this spreading the signal energy can be distributed uniformly in the spreading domain. Due to its even and symmetric signal energy distribution in time and frequency domains, the HC system combined with CDMA is natural and reasonable, in which spreading is adopted in both time and frequency domain simultaneously.

II. SYSTEM DESIGN MODEL

A. LTE standardization

Creating a standard for mobile communication does not happen over one night. Since it is an ongoing process and constantly developed, it can take one to two years until the standard is completed and even longer when products using this standard are commercialized and brought to market. When building standards from the scratch the time is even longer since there are no components to rely on. Standardization process typically includes four phases which are shown in Figure 1.



.

Figure 1: Four standardization phases.

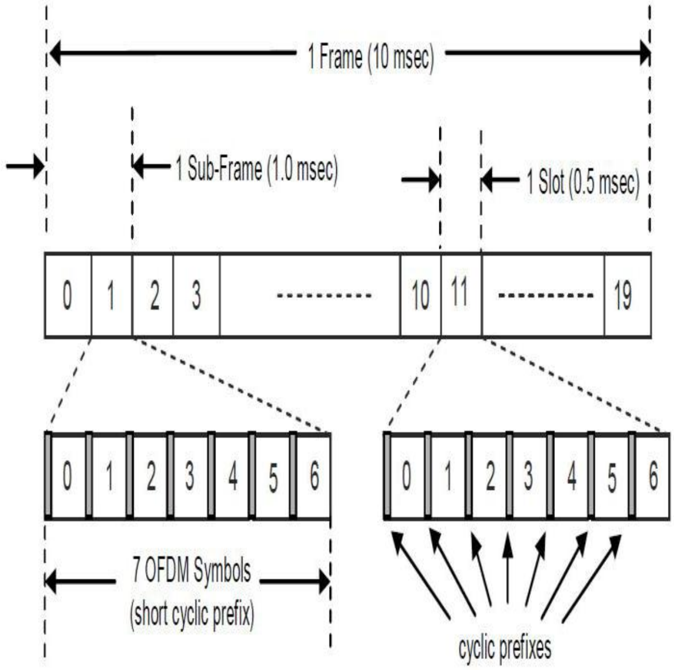
These phases include:

- Requirements, where it is decided what needs to be realized and where the goal is set
- Architecture, where the main building blocks and interfaces are fixed
- Detailed specifications, where every block and interface are described in detail
- Testing and verification, where the specifications are to work in praxis.

Theses phases are of course overlapping and interactive, hence requirements or techniques can be added, dropped or changed during the whole process, depending on the final technical solution. Standardization process begins with the requirement phase, where the basis is decided what must be achieved. This phase is rather short, however well-defined requirements can shorten the upcoming phases.
The goal is to provide a high data rate, low latency and a packet optimized radio technology which supports flexible bandwidth deployment. The targets for downlink peak data rate requirements are 100 Mbit/s and 50 Mbit/s for uplink, when 20 MHz spectrum is allocated. Both frequency division duplexing (FDD) and time division duplexing (TDD) are supported. The latency requirements are split over control plane and user plane requirements where round trip time is reduced to 10 ms or less, which provides interactive real time services. Control plane requirements is the time which is needed for user equipment (UE) to switch from non-active state to an active one to be able to send or receive data. Side requirement for control plane is number of supported UEs, which is listed to be at least 200 terminals in active state when operating at 5 MHz. Second requirement addresses the time needed to transmit a small IP packet from UE to the radio access network (RAN). LTE provides two to four times better spectral efficiency than Release 6 HSPA, which gives the opportunity to operators to increase number of customers in given spectrum.

B. LTE frame structure

Figure 2.Shows the LTE generic frame structure. Each radio frame has the length of 10 ms which contains ten equal sub frames of 1 ms length. The basic time unit is specified as Ts = 1/ 30720000s, hence the time of frame length can be specified as T frame = 307200Ts and sub frame as T sub-frame = 30720Ts. As already stated, LTE can operate in both FDD and TDD. Basically the frames are equal in the structure, furthermore TDD has a special sub frame inserted as seen in Figure 3.4. This special frame is used for the required guard time to switch from uplink to downlink transmission and vice versa.



.

Figure 2: LTE generic frame structure.

C. HC-CDMA system

For a square integrable function $g(x)$, its Fourier transform and inverse Fourier transform are $G(x) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} G(x)e^{jwx}\,dw$ and $g(x) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} G(x)e^{jwx}\,dw$. The system of $g(x)$ is expressed as a linear weighted combination of four basic state functions. The architecture of HC-CDMA system with K users is described in Fig. 3. In this system the sequences with length N are used as the address code sequences, and assign the normalized sequence c(i) = [$c(i)$ 0 , $c(i)$1 , · · · , $c(i)$ $N-1$] for the i-th user. At the transmitter, the M modulated data symbols are divided into a block. Spreading is applied in a certain order system domain, and the data are transformed to time domain by and then transmitted to the channel. At the receiver, according to the property of index additivity [8], that is $F\alpha$ _$F\beta$ [X] (l) = $F\alpha{+}\beta$ [X] (l), frequency domain equalization can be adopted here. Similarly to SC-FDE, the received signal is transformed to frequency domain by DFT, then FDE is applied to resist the channel fading. At last the data after equalization are transformed to the fractional Fourier transform domain again and demodulated after despreading. According to the channel conditions we can choose whether to add cyclic prefix (CP) and frequency domain equalization. When there is no inter-symbol interference, such as additive white Gaussion noise (AWGN) channel, CP and FDE can be omitted.

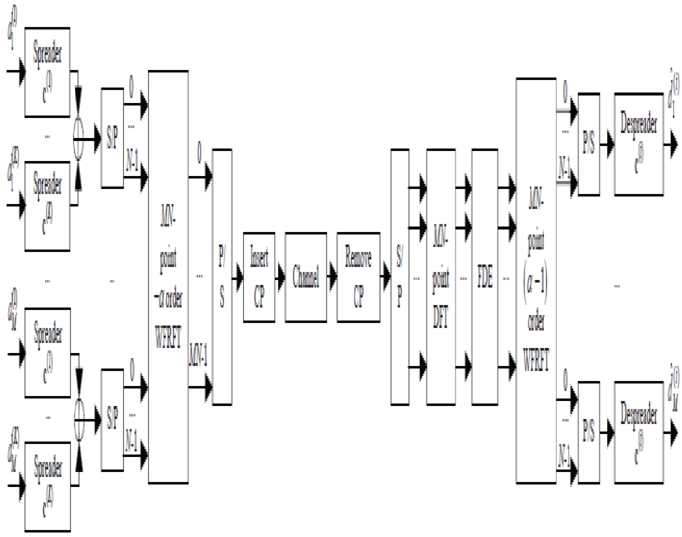
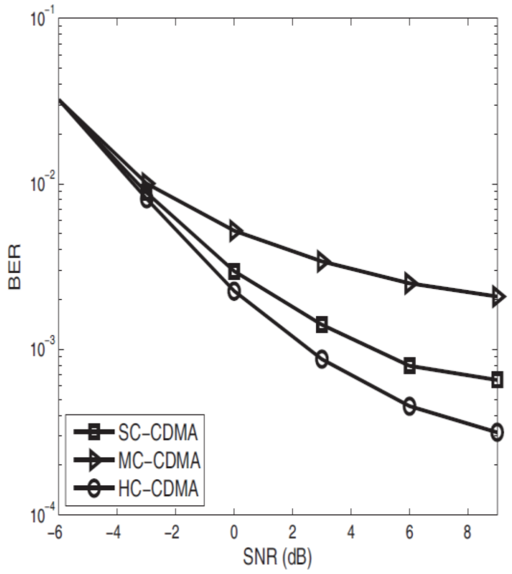


Fig. 3.Architecture of HC-CDMA system.

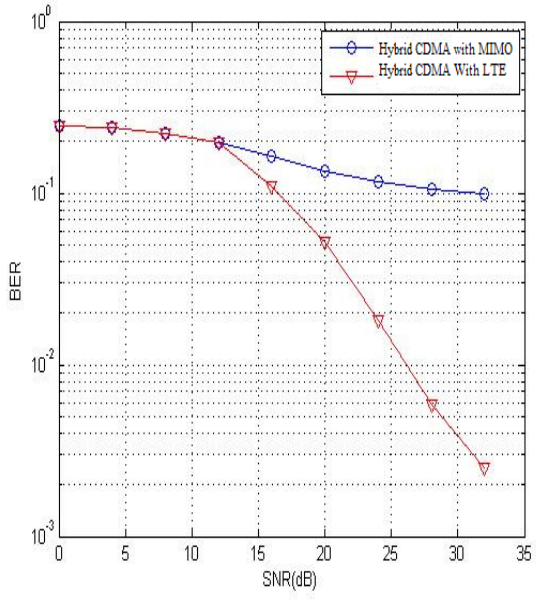
Particularly, HC-CDMA system can degenerate to SCCDMA or MC-CDMA system. When α = 0, it corresponds to SC-CDMA system, in which spreading is applied in time domain. While it transforms to MC-CDMA system when α = 1, which can be seen as the CDMA system with spreading in frequency domain. HC-CDMA is the CDMA system with time-frequency domain spreading simultaneously. By parameter altering, HC-CDMA is able to, not only degenerate to SC-CDMA or MC-CDMA, but also achieve a smooth and seamless transition between the two.

III. SIMULATION RESULTS

In the wideband communication system, the anti-interference ability is a performance measure. In the real world, scenario that several communication systems share the same band is inevitable. And the narrow-band interference which is commonly modeled as a single-frequency signal is an important factor for system performance. Single-frequency interference will generate strong interference to a point in frequency domain. In MC-CDMA system, spreading is applied in frequency domain and the signal at single-frequency interference point is sensitive to the strong interference. Thus the performance degradation at this point leads to system BER rise. While in SC-CDMA spreading is implemented in time domain, each data symbol is spread over all the sub-carriers.



In this case, the hybrid CDMA shows its true efficiency for the performance of LTEDownlink systems and MIMO system. The inserted cyclic prefix is shorter than the channel length and this can bedue of some unforeseen behavior oh the channel



IV. COCNCLUSION

We propose a hybrid CDMA estimation technique able to perform LTE Downlink systems under the channel length effect. Simulations results have shown the efficiency of the proposed technique and especially for the case where the channel length exceeds the cyclic prefix. In HC-CDMA system, the modulated data is spreading in a certain fractional domain and transformed by the LTE to time domain. Besides multiple accesses, CDMA technique also plays a role in resistance to fading. The signal energy distribution is more even and uniform in the HC system, resulting in the better anti-jamming capability. Simulation results and theoretical analysis show that HC-CDMA system in the single-frequency interference and multi-path fading channels achieves the optimal performance compared to MC-CDMA and SC-CDMA.

REFERENCES

[1] Ericsson. LTE - an introduction, June 2009.White paper available at http://www.ericsson.com/res/docs/whitepapers/lte_overview.pdf.

[2] Erik Dahlman, Stefan Parkvall, Johan Sköld, and Per Beming.HSPA and LTE for Mobile Broadband.Academic Press, Oxford, United Kingdom, 2008.

[3] Farooq Khan. LTE for 4G Mobile Broadband.Cambridge University Press, Cambridge, United Kingdom, 2009.

[4] Sanjay Kumar Sarkar. A Long Term Evolution (LTE) Downlink DL inspired channel simulator using the SUI 3 channel model, August 2009.

[5] L. Liu, Y. L. Guan, G.A. Bi, and D. R. Shao, "Effect of carrier frequency offset on single-carrier CDMA with frequency-domain equalization," *IEEE Trans. Veh. Tech.*, vol. 60, no. 1, pp. 174–184, Jan. 2011.

[6] F. Adachi, D. Garg, S. Takaoka, and K. Takeda, "Broadband CDMA techniques," *IEEE Wireless Commun.*, vol. 12, no. 2, pp. 8–18, Apr. 2005.

[7] K. Fazel, "Performance of CDMA/OFDM for mobile communication system," in *Proc. ICUPC'93*, vol. 2, pp. 975–979.

[8] A. Ling and L. Milstein, "The effects of spatial diversity and imperfect channel estimation on wideband MC-DS-CDMA and MC-CDMA," *IEEE Trans. Commun.*, vol. 57, no. 10, pp. 2988–3000, Oct. 2009.

[9] U. Li, S. Mclaughlin, D. G. M. Cruickshank, and X. S. Wei, "Towards multi-mode terminals," *IEEE Veh. Technol. Mag.*, vol. 1, no. 4, pp. 17–24, Dec. 2006.

[10] L. Mei, X. J. Sha, and N. T. Zhang, "The approach to carrier scheme convergence based on 4-weighted fractional fourier transform," *IEEE Commun. Lett.*, vol. 14, no. 6, pp. 503–505, June 2010.