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A Review 4G system QAM MC-CDMA Higher Data Rates Transmission Systems in Impulsive Noise

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ABSTRACT: MC-CDMA and MCDS- CDMA systems to carrier offset in a frequency selective channel, with a zero forcing (ZF) or a minimum mean square error (MMSE) equalizer. The data rate and spectrum efficiency of wireless mobile communications have been significantly improved over the last decade or so. Recently, the advanced systems such as 3GPP LTE and terrestrial digital TV broadcasting have been sophisticatedly developed using OFDM and CDMA technology. In Impulsive Noise remove general, most mobile communication systems transmit bits of information in the radio space to the receiver. The radio channels in mobile radio systems are usually multi path fading channels, which cause inter-symbol interference (ISI) in the received signal. To remove ISI from the signal, there is a need of strong equalizer which requires knowledge on the channel impulse response (CIR).This is primarily provided by a separate channel estimator. Usually the channel estimation is based on the known sequence of bits, which is unique for a certain transmitter and which is repeated in every transmission burst. Thus, the channel estimator is able to estimate CIR for each burst separately by exploiting the known transmitted bits and the corresponding received samples. In this thesis we investigate and compare various efficient channel estimation schemes for OFDM systems which can also be extended to MC DS-CDMA systems. The channel estimation can be performed by either inserting pilot tones into all sub carriers focused employing Least Square Error (LSE) and Minimum Mean Square Error (MMSE) channel estimators. Block type pilot sub-carriers is especially suitable for slow-fading radio channels whereas comb type pilots provide better resistance to fast fading channels.

Keywords: *MC-CDMA, zero forcing, MMSE, MC DS-CDMA,*

I. INTRODUCTION

The analysis of a new spread spectrum transmission method called MC-CDMA. MC-CDMA [1,2,3] addresses the issue of how to spread the signal bandwidth without increasing the adverse effects of the delay spread, which is a measure of the length of the channel impulse response. With MC-CDMA, a data symbol is transmitted over *N* narrowband sub carriers where each sub carrier is modulated by “1” or “-1” based on a spreading code. Different users transmit over the same set of sub carriers but with a spreading code that is orthogonal to the codes of other users. If the number of and spacing between sub carriers is appropriately chosen, it is unlikely that all of the sub carriers will be located in a deep fade and consequently frequency diversity is achieved. As an MCCDMA signal is composed of *N* narrowband sub carrier signals each with a symbol duration much larger than the delay spread, an MC-CDMA signal will not experience significant degradation from inter-chip interference and inter-symbol interference (ISI) [4,5].

II. BASIC PRINCIPLES

The input data symbols, am[k], are assumed to be binary antipodal where k denotes the kth bit interval and m denotes the mth user. In the analysis, it is assumed that am[k] takes on values of -1 and 1 with equal probability. The generation of an MC-CDMA signal can be described as follows. a single data symbol is replicated into N parallel copies. Each branch of the parallel stream is multiplied by a chip from a spreading code of length N. Each copy is then binary phase-shift keying (BPSK) modulated to a sub carrier spaced apart from its neighboring sub carriers by F/Tb Hz where F is an integer number. An MC-CDMA signal consists of the sum of the outputs of these branches.

This process yields a multi-carrier signal with the sub carriers containing the orthogonally coded data symbol, the transmitted signal corresponding to the kth data bit of the mth user is the Orthogonal Frequency Division Multiple (OFDM) access schemes have been gaining a lot of attention for next generation of mobile communication systems because of its immunity to the multi path interference and effective spectrum utilization. The successful adaptation of the OFDM access scheme for European Digital Audio Broadcasting (DAB) and Digital Video Broadcasting (DVB) systems have catapulted this as a forerunner for the 4th generation of wireless communication systems and have already been adapted for the high data rate IEEE 802.11a/g and HiperLan2 Wireless Local Area Network (WLAN) applications. This tutorial will cover the basic principles and characteristics of OFDM systems. The problems and some of the potential solutions to the practical issues in implementing such a system will be presented. These include but not limited to time and frequency synchronization, channel estimation, channel equalization and techniques for peak-to-average power ratio reduction. Finally, we conclude the tutorial with an example of a real wireless OFDM transceiver design. Phase noise is a random fluctuation in the phase of an oscillator waveform. An ideal oscillator would generate a pure sine wave and this would be represented as a single pair of the delta function at the oscillator's frequency in the frequency domain. All real oscillators have phase modulated noise components. The phase noise components spread the power of the signal to adjacent frequencies, resulting in noise sidebands. Phase noise is an important issue in the wireless systems and it has been discussed in many papers such as [1,2]. The oscillator phase noise model is studied in [3,4] and the analysis of the practical devices such as phase-locked loop (PLL) with the phase noise has been reviewed in [4,5]. Orthogonal frequency division multiplexing (OFDM) modulation is widely suffered from the phase noise. The performance of the OFDM modulation with the phase noise, power amplifier nonlinearity and in-phase (I) and quadrature (Q) imbalance is studied in [6–8]. In [6], the oscillator phase noise and power amplifier nonlinearity effects are investigated analytically and in [7], the authors focus on inter-carrier interference (ICI) and a closed-form solution for the signal to interference plus noise ratio (SINR) is derived. In addition, the results of the phase noise in multiple-input multiple-output (MIMO) channel sounding and multi-antenna beam forming are also discussed in [9] and [10] respectively. Carrier recovery system in a digital transmission system which is impacted by the phase noise is studied in [11]. Also, the phase noise effects on error vector magnitude (EVM) of a system are proposed in [12,13] where a theoretical expression is derived for the EVM in the M-QAM systems. Some analysis on the symbol error rate of the digitally modulated systems is executed in [12] and a union bound for the symbol error rate is derived. The same integral-form expression is also obtained in [13], but there is no closed-form solution for the symbol error rate of the M-QAM systems until now. Symbol error rate is a very important tool for investigating the performance of telecommunication systems and it is studied in various systems and problems for many years. In the phase noise context, there are many studies and different approximate representations for the bit and symbol error rate in digital modulations and OFDM systems [2,5,6]. To the best of our knowledge, there is no exact closed-form expression for the symbol error rate of M-QAM digital communication systems with the phase noise imperfection. In this paper we assume square and rectangular M-QAM constellation in the additive white Gaussian noise (AWGN) channel and error probability for each symbol of the constellation is derived over the decision boundary of the symbol. Then, the symbol error rate is obtained as a finite summation of two-dimensional Q-function over the whole points of the constellation. Although AWGN is a simple channel, but the analysis in the AWGN channel is the first step for the further investigations in the fading channels. After the exact calculation of the symbol error rate at the AWGN channel, using the distribution of the signal to noise ratio (SNR) in the fading channel, the symbol error rate in the fading channel is extracted. Market research finds that mobile commerce for 4G wireless systems will be dominated by basic human communication such as messaging, voice, and video communication. Because of its typically large bandwidth requirements, broadband communication is expected to emerge as the dominant type of traffic in 4G wireless systems. In this paper a new TCP based Multicarrier access technique named MC-CDMA for mitigating 4G requirements is proposed. This paper also presents analytical information regarding the transfer of TCP data flows on paths towards interconnected wireless systems, with emphasis on 4G cellular networks. The focus is on protocol modifications in face of problems arising from terminal mobility and wireless transmission. We advocate the use of TCP as the transport layer protocol for highs peed data in a Multi-Carrier CDMA (MC-CDMA) system for 4G wireless communications. The 4G will be a fully IP-based integrated system of systems and network of networks achieved after the convergence of wired and wireless networks as well as computer, consumer electronics, communication technology.

Several other convergences that will be capable of providing 100 Mbit/s and 1 Gbit/s, respectively, in outdoor and indoor environments with end-to-end QoS and high security, offering any kind of services anytime, anywhere, at affordable cost and one billing [1]. The proliferation of the Transmission Control Protocol (TCP) in Internet communications today incites the research community to further extend its use in mobile and wireless networks. The ultimate goal is efficient and reliable TCP flows for Internet traffic over interconnected wired and wireless paths, where the wireless path suffers from additional problems due to higher BERs (Bit Error Rates) and frequent link changes. This primarily entails the treatment of protocol issues, but also additional interoperability in the network infrastructure. In the large-scale mobility case, cellular networks of the 4th generation (4G) are the most suitable candidates for support of Internet traffic, as they offer capacity for enhanced broadband data transfers, as well as improved transmission quality. In this paper, we describe the vision of the 4G systems focusing on major key technology such as MCCDMA system. The remainder of this paper is organized as follows. aspects of 4G cellular environment and MC-CDMA system

III. VIEW OF 4G MOBILE AND WIRELESSCOMMUNICATION SYSTEMS

4G Mobile and wireless communication systems should support following functions:

1. Higher transmission rate up to 100Mbps
2. Flexible to advanced Internet, QoS control
3. Enhanced security
4. Seamless operation across networks
5. Multiple broadband access options in combined public and private networks including wireless LAN, wireless home link and ad-hoc network. 1G and 2G systems were voice communications, and digitized voice communications with some data communications, respectively, where a major difference was roaming between regions. 3G systems provide multimedia and wireless Internet at relatively high data rates, by utilizing packet switched services. However, significant paradigm shift should be taken into account for 4G systems, since wireless LAN, wireless MAN (WiMAX), wireless ad-hoc and sensor networks are becoming popular. Fig. shows the evolution of networking and paradigm shift. Up to 2001, web-based service by using dial-up or always-on IP connection has been dominant. Now, mobile Internet is very popular and the driving force is mobile. The flexible and secure broadband seamless networking is the key to establish Ubiquitous network which is characterized by distributed computing, broadband and wireless, and peer-to peer for everything, and driving force is service. In our view, 4G systems are regarded as a "shopping mall type", whereas3G systems are "department store type". Key issues for seamless operation are given in figure.

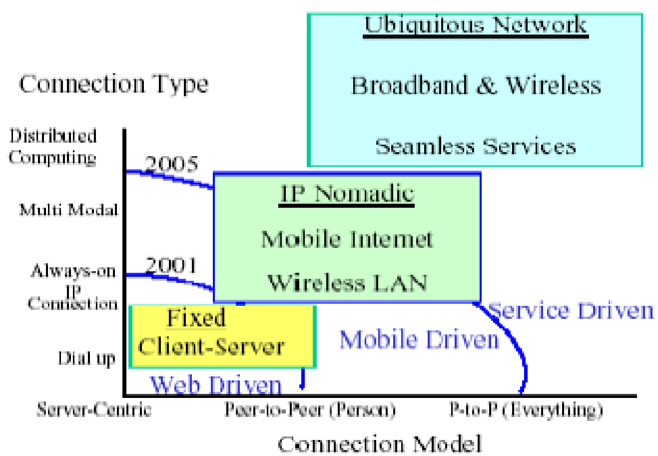

Fig. 1. The evolution of networking and paradigm shift.

1. Service discovery and fast seamless connections/ services in the IP-based multi-modal access
2. Mobility management
3. IP multimedia services platform independent of radio access technology and underlying IP transport technology
4. Enhancement to support Human (H) to H, H to Machine (M) and M to M communications
5. Flexible introduction of new technologies into a system and service Fig.shows view of the IP-based 4G mobile and wireless network architecture. IP-based backbone transport network supports multi-modal access among various wireless networks. As a lower middleware, the basic network management layer treats many functions related to multiple interface management, mobility management using mobile anchor point with buffer, security, QoS etc. As an upper layer of the services middleware, service support layer handles location, billing, media conversion, distribution etc. Application can be operated by using suchcommon service middleware. 4G systems are also characterized by the bandwidth to be allocated. In 2-5 GHz band, propagation loss is higher resulting in smaller cell size. Also, due to higher Doppler shift, more complex and robust synchronization and channel estimation techniques are needed. Key technologies being researched in physical layer are OFDM, multi-carrier CDMA (MCCDMA), multi-hop systems, MIMO and AAA, Time Division Duplex (TDD) CDMA, and downlink queuing and scheduling algorithm, routing protocol and distributed public key management for mobile ad-hoc networks in higher layers.

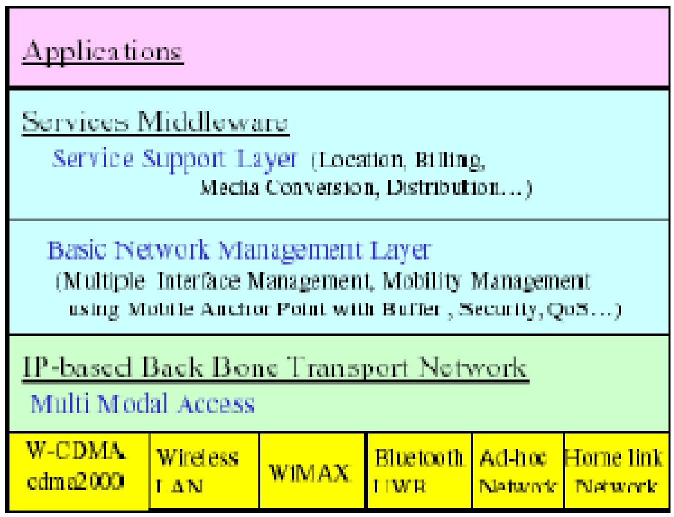

Fig. 2. View of the IP-based 4G mobile and wireless network architecture.

IV. MC-CDMA TECHNIQUES FOR 4G SYSTEMS

Fig. shows the evolution of mobile communications systems. In discussions about 2G systems in the 1980s, two candidates for the radio access technique existed, time division multiple access (TDMA) and CDMA schemes. Finally, the TDMA scheme was adopted as the standard. On the other hand, in the discussions about 3G systems in the 1990s, there were also two candidates, the CDMA scheme, which was adopted in the one generation older systems, and the OFDM-based multiple access scheme called band division multiple access (BDMA) [2]. CDMA was finally adopted as the standard. If history is repeated, namely, if the radio access technique that was once not adopted can become a standard in new generation systems, then the OFDM-based technique looks promising as a 4G standard. It is well known that the CDMA scheme is robust to frequency selective fading. Likewise, the OFDM scheme is a1so inherently robust to frequency selective fading.

Thus the combination of OFDM and CDMA schemes may give batter performance. In 1993, Multi-carrier CDMA (MC-CDMA) system which is indeed a combination of OFDM and CDMA schemes was independently proposed by three different groups [4-6] almost simultaneously. Currently, an updated DS-CDMA technique is being used for the 4G mobile communication systems [7].

However the MC-CDMA looks more promising for the 4G standard. In DS-CDMA, Rake receivers are used, which have complexity in design and provide low performance. Thus, DS-CDMA is no longer the best choice available for the 4G standard. On the other hand, MC-CDMA system directly applies coding in the frequency domain to separate each user and thereby making it possible to support multiple users. This system is more effective in eliminating the frequency selective problem faced in the DS-CDMA system by not dividing the user bits into chip to uniquely encode them [7]. Instead, the user's codes are employed in different frequency and thus offer longer bit duration and make the signal to experience only flat fading. This is how it mitigates the problem of inter-chip interference [8]. Moreover, MC-CDMA system has lot of flexibility inherent in terms of system design that allows better spectrum utilization [9]. It also has the benefit of relatively simple receiver structure. optimization/modification approaches. The approach presented in this paper belongs to the latter category. Hence, notwithstanding their importance, we only briefly mention some of the works in this category. TCP enhancement consists of approaches that either introduce end-to-end TCP modifications or split the TCP connection with the help of an intelligent agent. A few examples of the former are TCP Westwood [10], TCP-Freeze [11] and the Eifel timer [12]. Examples of the latter are Snoop [6] and the ACK and Window-regulator [13,14]. We refer the reader to [1,6] for a more detailed survey. The intercede interference in frequency-selective Rayleigh fading channels in MC-CDMA is evaluated and the theoretical expressions for the desired-to-undesired signal power ratio (DUR) is derived by strictly considering the correlation property between subcarriers in [7]. The optimum spreading code assignment method is proposed in MCCDMA cellular systems over correlated frequencyselective Rayleigh fading channels based on the DUR imbalance among assigned spreading codes [8]. The 4G MC-CDMA systems [2] will be able to provide data rates of up to 2 Mbps per user, which is an appreciable improvement over the current day CDMA systems that can only provide up to 9.6kbps per user. An outcome of the increased data rates is that the transmission delays at BS are lowered which reduces the probability of interference between the TCP level and link level retransmissions significantly and thus makes the link layer mechanisms more viable. We feel that there is a strong need to further explore the link layer retransmission techniques in light of high data rates that will become available in the next generation (4G) MC-CDMA systems.

V. CONCLUSION

We have proposed various techniques that provide mechanisms at different layers, which help in improving the performance of TCP in MC-CDMA cellular wireless networks. We feel that the physical and link layer techniques are absolutely necessary to deal with the harsh mobile radio environment. In addition, one or more transport layer techniques (may not be limited to the ones mentioned in the paper) may be combined judiciously with them to further improve the performance of TCP. The study of TCP performance in MC-CDMA environment has vast research potential, especially because the next generation cellular networks (4G) [25] have chosen MC-CDMA as the air interface protocol of choice.

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