Chapter XXXIII
ISI Cancellation in 4G Wireless Mobiles

Kumar Priyatam
BVB Collage of Engineering and Technology, India

R. M. Banakar
BVB Collage of Engineering and Technology, India

B. Shankaranand
National Institute of Technology, India

ABSTRACT

Physical layer issues of broadband wireless communication systems form the bottleneck in providing fast and reliable communication over wireless channel. Critical performance limiting challenges are time selective fading channels, frequency selective fading channels, noise, inter symbol interference (ISI), inter carrier interference, power, and bandwidth. Addressing these challenges of wireless broadband communication systems, one can provide faster data processing with lower computational complexity, higher data throughput, and improved performance in terms of bit error rate (BER). In this chapter an effective technique (SISO estimation) to handle interference cancellation is developed. ISI is caused by multi-path propagation. It can be reduced by using a channel equalizer which provides the receiver with the prior knowledge of the channel. Channel estimation is a technique to acquire behavior of the channel. Accuracy of the channel estimation improves the system performance. At BER of 10-4 SISO estimator provide an improvement of 2dB as compared with MMSE DFE estimator.

INTRODUCTION

Fourth Generation (4G) mobile systems are expected to provide global roaming across different types of wireless and mobile network. Communication may be from satellite to mobile networks and to Wireless Local Area Networks (WLANs). Main objective of 4G is to overcome the shortcomings and limitations of 3G systems prime amongst which is the issue of available bandwidth.

The term 4G is used broadly to include several types of broadband wireless access communication systems, including cellular telephone systems. One of the terms used to describe 4G is MAGIC—Mobile multimedia, Anytime anywhere, Global mobility support, Integrated wireless solution, and Customized

Copyright © 2009, IGI Global, distributing in print or electronic forms without written permission of IGI Global is prohibited.

personal service. The vision of 4G wireless/mobile systems are of broadband access, seamless global roaming and Internet/data/voice communication. The 4G system provide facilities to integrate terminals, networks and applications to satisfy the increasing user demands.

The 4G mobile networks are being developed with two main objectives. One of these objectives is to overcome the shortcomings and limitations of 3G, prime amongst is the issue of available bandwidth. 4G systems are expected to offer a speed of over 100 Mbps in stationary mode and an average of 20 Mbps for mobile stations reducing the downlink time of graphics and multimedia components by more than ten times compared to currently available 2 Mbps on 3G. The second main objective behind 4G development is to make good use of the achievements in the area of wireless technology. Currently 4G system is a research and development initiative based upon 3G, which is having trouble meeting its performance goals. The challenges for development of 4G systems depend upon the evolution of different underlying technologies, standards and deployment.

Presently there are various techniques to minimize ISI. To remove ISI equalizers are used. The prevailing methods are liner equalizer (LE), least-mean-square (LMS), Kalman estimation (KEST) and recursive-least-square (RLS), which concentrate on multipath channel and fading amplitudes. In the above mentioned methods the computational complexity is high and the delay time is not optimized for the BER of 10^{-6}. These methods operate on the present sample of data only. They do not consider the previous or next data sample to predict present data. The novel approach presented in this paper overcomes the above mentioned demerits. Performance improvement is observed by using this new approach.

Most commonly used equalizers are ML sequence estimation (MLSE) or MAP symbol estimation (MAPSE). An efficient implementation of the MLSE equalizer is the Viterbi Algorithm (VA), which is described in standard literature about coding [5]. A MAPSE equalizer is often based on the forward backward algorithm from Bahl et al. (BCJR) [6]. Compared to the original paper, Rabiner [7] provides a more tutorial introduction on the BCJR algorithm. Forney [8] applied the VA to MLSE for digital communication on ISI channels including an extensive analysis of its performance.

All known MAP/ML based methods suffer from high computational complexity with increasing channel length M and alphabet size q due to the exponential complexity $O(q^M)$ Furthermore , they can be applied directly only block wise, since a time reversed backward step is involved. Complex algorithms exist to overcome these using sliding window techniques such as "Turbo coding "applications [9].

The received data is segmented into frames and these frames are received over a time period specified by the window. The basic idea is to obtain a symbol estimating by filtering the received data (LE) or by filtering the past symbol decisions (DFE). Both the LE and DFE contain linear filters as basic functional elements. The DFE also contains nonlinearity, namely a hard decision element, to provide estimates of past symbols for feedback. To implement the linear filters, several structures such as transversal, cascade, parallel or lattice filter implementations are available. The associated parameter to set up the filters are obtained using the channel response h[n] cost criteria such as the zero forcing (ZF) or minimum mean squared error (MMSE) criterion. Receivers using LE and DFE approaches are inherently suboptimal in terms of error probability since they are designed using different cost criteria. Also, some inherent weakness such as constraint filter lengths, noise enhancement in ZF based solutions, or error propagation in DFE solutions limit the capabilities of pure LE or DFE approaches. None the less, they are widely used in practice since a broad knowledge about them is available and computational complexity is significantly smaller compared to optimal techniques introduced in the LF/DFE.

A number of standard texts [1,2] in the communication literature contain more information about LE and DFE approaches. A valuable review about LE/DFE system using ZF/MMSE criteria is available [3], together with probability of error analysis techniques. More advance LE/DFE techniques include fractionally spaced (FS) or state space (SS) LE or DFE approaches. Other than symbol spaced receivers, FS receivers sample the matched filter output at an integer multiple rate of the symbol rate T to decrease aliasing.

For digital communication, a common cost criterion is the bit error rate (BER) of the system, which does not necessarily coincide with equalization criteria. The optimum receiver with respect to minimization of the BER is a maximum a-posteriori probability (MAP) or maximum likelihood (ML) detector does not remove ISI, but tries to find the most likely channel input given the output symbols disrupted by noise, which is equal to minimizing the BER. Whereas a ML detector assumes the symbols to be equally likely to occur on any value of the symbol alphabet, a MAP detector employs knowledge about the occurrence probability

12 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:
www.igi-global.com/chapter/isi-cancellation-wireless-mobiles/19558

Related Content

Electronic Customer Relationship Management (E-CRM) and Customer Loyalty: The Mediating Role of Customer Satisfaction in the Banking Industry
Pushpender Kumarand Anupreet Kaur Mokha (2022). *International Journal of E-Business Research (pp. 1-22).*
www.irma-international.org/article/electronic-customer-relationship-management-e-crm-and-customer-loyalty/293292

How Consumer Perceptions of Network Size and Social Interactions Influence the Intention to adopt Peer-to-Peer Technologies
Jaeki Songand Eric Walden (2007). *International Journal of E-Business Research (pp. 49-66).*
www.irma-international.org/article/consumer-perceptions-network-size-social/1892

“Smart Home Sweet Smart Home”: An Examination of Smart Home Acceptance
Davit Marikyan, Savvas Papagiannidisand Eleftherios Alamanos (2021). *International Journal of E-Business Research (pp. 1-24).*
www.irma-international.org/article/smart-home-sweet-smart-home/273196

Laws and Regulations on Proprietary Trading System (PTS) in Japan: Japanese Alternative Trading System (ATS)
Motoaki Tazawa (2008). *Cyberlaw for Global E-business: Finance, Payments and Dispute Resolution (pp. 67-87).*
www.irma-international.org/chapter/laws-regulations-proprietary-trading-system/7490

To Bid or to Buy?: Online Shoppers’ Preferences for Online Purchasing Channels
Fan-Chen Tseng (2012). *Transformations in E-Business Technologies and Commerce: Emerging Impacts (pp. 1-19).*
www.irma-international.org/chapter/bid-buy-online-shoppers-preferences/61355