PERFORMANCE ANALYSIS OF PARTIALLY COHERENT FREQUENCY-SELECTIVE CHANNELS WITH DOPPLER SHIFT

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ABSTRACT

Simulation results are presented to demonstrate the effect of Doppler frequency shift on the error rate performance of partially coherent PSK systems in frequency-selective environment. Frequency-selective fading channels are modeled as two-ray Rayleigh fading in where the presence of the delayed ray cases intersymbol interference (ISI). We consider diversity system with L-branch signals that being detected using postdetection equal-gain combining (EGC) receiver. The effect of ISI on the system performance is assessed using exhaustive method in where a truncated pulse train of the ISI signal is considered. Square root raised-cosine filters are used in both the transmitter and receiver for an optimum performance in a band-limited channels. The results are discussed and specified using a useful time-reduction quazi-analytical simulation technique.

I. INTRODUCTION

The received signal over wireless channels contains multiple versions of the transmitted signal that are time delayed, phase shifted, and attenuated. The net result is a time dispersion of the transmitted signal. When the channel possesses a constant gain and linear phase response over a bandwidth (usually called the coherence bandwidth of the fading channel) that is smaller than the bandwidth of the transmitted signal, then the transmitted signal undergoes frequency selective fading in the channel. The frequency selectivity property manifests itself at the receiver as ISI. In wireless environment, ISI basically occurs if the difference on the path delays (i.e., the Delay spread) is significant compared to the symbol period. Further, due to the relative motion between the mobile and base station and/or the movements of objects in the channel, a received Doppler spectrum is expected. Therefore, a practical propagation scenario over multipath wireless channel results in both time and frequency dispersions of the received signals.

Under the previous mentioned time-variant characteristics of the wireless channel, neither the carrier phase nor the delay spread of the received signals can be derived perfectly. Hence, the carrier phase is usually partially recovered in coherent systems and the frequency selectivity property of the multipath fading channel will cause ISI. Since the exact evaluation of the performance and the resulting degradation is a formidable task, we present a quazi-analytical simulation technique to analyze the performance of frequency-selective partially coherent PSK systems in the presence of ISI. We consider in the analysis EGC diversity scheme as a powerful communication technique that provides wireless link improvement at relatively low cost.

The performance of frequency-selective fading channels for both coherent and differentially coherent PSK systems has received a lot of attention. The performance of digital transmission over frequency-selective Rayleigh fading diversity systems has been investigated early in [1] and [2]. Analytical expressions for the average bit error probability (BEP) of two-ray Rayleigh fading channel were obtained for DBPSK in slow fading with cochannel interference (CCI) in [3] and for DQPSK in fast fading with CCI in [4]. Simulation results for the average BEP of frequency-selective DQPSK system are also presented in [5]. Additionally, the Gaussian approximation is used for the CCI signals in [6] to investigate the performance of coded and uncoded correlated Rayleigh fading M-ary DPSK channels with two branches EGC. In the last four studies the effect of Doppler frequency shifts was considered. Recently, the author in [7] provided quazi-analytical simulation results for the error rates of perfect coherent BPSK and QPSK frequency-selective slow Rayleigh fading channel without diversity.

All the above studies on PSK systems assumed perfect coherent recovery of the carrier phase. The impact of the carrier phase errors on the BEP performance of BPSK and QPSK with EGC over slow Rayleigh, Rician, and Nakagami-m fading channels has been analyzed and extensively discussed in [8]. However, in this work frequency-nonselective environment was considered so that the effects of Doppler shift and ISI were not taken into account. Hence, this paper extends the previous works through studying the effect of the Doppler shift on the error rate performance of partially coherent BPSK and QPSK systems in frequency-selective slow fading diversity channels. Slow fading implies that the effect of time-selective fading can be neglected so that the bit errors are mainly produced by the multipath fading, the Doppler shift, the ISI, the carrier phase errors, and the additive white Gaussian noise (AWGN).

The remainder of this paper is organized as follows. After introducing the signal and channel models used in our analysis in Section II-A, the EGC receiver structure for 2-ray frequency-selective slow fading channels is described and it's corresponding decision statistic is derived in Section II-B. In Section III, we derive the conditional BEP expressions for partially coherent BPSK and QPSK in frequency-selective slow fading channels. Following that, simulation results that demonstrate the effect of the frequency Doppler spread on the

1-4244-0330-8/06/$20.00©2006 IEEE