This full text paper was peer reviewed at the direction of IEEE Communications Society subject matter experts for publication in the IEEE GLOBECOM 2005 proceedings.

Partially Coherent BPSK Diversity Receivers in Cochannel Interference

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***Abstract*— In this paper, we analyze the bit error probability (BEP) of L-branch BPSK channels in the presence of cochannel interference (CCI) and carrier phase error. We consider a generalized propagation model in where the desired and interfering signals allow to follow Nakagami-m or Rician fading with different amounts of fading strength. Also, a general asynchronous CCI signals are analyzed so that the effect of cross-signal intersymbol interference (ISI) is taken into account. The diversity branches are independent, not necessarily identically distributed or having equal power levels, and they experience slow frequency-nonselective fades. Extensive error rate results are presented and several comparisons based on the interfering users' signals condition are established.**

I. Introduction

In wireless communications, and due to frequency reuse technique, a desired mobile user signal is corrupted by the interference generated by other undesired active users' signals in the neighboring cells operating at the same carrier frequency. This results in CCI, a problem that has been categorized as the bottleneck for the capacity of any wireless cellular system. Also, because of the time-variant characteristic of the channel, the carrier phase cannot be recovered perfectly (i.e., partially coherent detection), which will indeed degrade the performance. Therefore, it is of practical importance to study the performance of coherent wireless systems in the presence of CCI and carrier phase error. Since diversity combining is widely used as a powerful technique to combat the negative effect of wireless channel impairments, we consider the well-known equal-gain combining (EGC) diversity method.

Different CCI environments have been proposed to characterize the propagation of the desired and interfering signals. In early analysis, both the desired and the interfering user signals are modeled by Rayleigh fading. However, in microcellular environments, the fading is not as much severer as Rayleigh fading and it is better to be characterized by either Nakagami-m or Rician fading. Therefore, a Nakagami-m/Nakagami-m model or Rician/Rician model, in where the desired user signal is described by Nakagami-m or Rician fading and the interfering signals are described by Nakagami-m or Rician fading with different amounts of fading severity are general enough models to cover a wild range of real fading conditions. On the other hand, in practical systems, the interfering signals are not timing synchronized with the desired signal. Thus, we consider here both Nakagami-m/Nakagami-m and Rician/Rician models under asynchronous or synchronous CCI to evaluate the error rates of partially coherent BPSK diversity systems.

Many papers dealt with the error rate performance of coherent BPSK systems in slow frequency-nonselective fading and CCI. The authors in [1] derived closed-form solution for the average BEP in synchronous Nakagami-m/Nakagami-m CCI. However, the solution in [1] is reached under the assumption that the sum of the Nakagami-m interfering signals is Gaussian, which still an approximation. Recently, the exact BEP's of asynchronous interferers with rectangular pulse shape filtering systems are derived in [2] for Rayleigh/Rayleigh model and in [3] for Nakagami-m/Nakagami-m model. More generally, the error rate performance for several bandwidth-efficient pulse shape signaling in Nakagami-m/Nakagami-m asynchronous CCI is studied in [4]. For diversity systems, the BEP for coherent BPSK was studied for dual-branch system with asynchronous Nakagami-m or Rician/Rayleigh CCI in [5] and for L-branch EGC with synchronous multiple Rician CCI in [6]. However, in all previous studies, perfect coherent detection is assumed. To the best of our knowledge, the error rate performance of partially coherent BPSK wireless signals with or without diversity, for asynchronous or synchronous CCI, has not been investigated so far.

II. System and Channel Models

We consider a coherent BPSK system with CCI in frequency-nonselective slowly fading environments. The complex baseband representation of the desired transmitted signal is given by

$$s_d(t) = \sqrt{2P_d} \sum_{k=-\infty}^{\infty} e^{j\theta_d(k)} h_T(t - kT), \tag{1}$$

where P_d is the transmitted bit power and $\theta_d(k)$ represents the information phase in the kth signaling interval which takes values from $\{0, \pi\}$ radians with equal probabilities. The impulse response of the transmitter filter, $h_T(t)$, is assumed to be constant (rectangular pulse) over the bit time period T and its energy is normalized to 1, i.e., $h_T(t) = \frac{1}{\sqrt{T}}, \quad 0 \leq t \leq T$.

As the desired signal propagates over wireless channel, it suffers from multipath fading as well as interference from

