COMPARATIVE ANALYSIS OF PARTIALLY COHERENT AND DIFFERENTIALLY COHERENT PSK SYSTEMS WITH FADING AND COCHANNEL INTEREFERENCE

by

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Presented to the Faculty of the Graduate School of
The University of Texas at Arlington in Partial Fulfillment
of the Requirements
for the Degree of

DOCTOR OF PHILOSOPHY

THE UNIVERSITY OF TEXAS AT ARLINGTON

December 2016

To my mother Sari and my uncle Luis Alfredo (my father figure)

who set the example and who made me who I am.

ACKNOWLEDGEMENTS

I would like to thank my supervising professor Dr. Vasant Prabhu for constantly motivating and encouraging me, and also for his invaluable advice during the course of my doctoral studies. I wish to thank my academic advisors Dr. Jonathan Bredow, Dr. Chien-Pai Han, Dr. Harold Sobol, Dr. Saibun Tjuatja and Dr. Stone Tseng for their interest in my research and for taking time to serve in my dissertation committee.

I would also like to extend my appreciation to Nortel Networks for providing financial support for my doctoral studies. I wish to thank Meng Yee, Robert Hunt and Dr. Michael Maragoudakis with Wireless Network Engineering for their support and encouragement. I am especially grateful to Mazin Al-Shalash for his interest in my research and for the helpful discussions and invaluable comments. I wish also to thank Dr. Yaser Ibrahim, Dr. Mini Vassudevan and Kal Mustafa for taking the time to critically evaluate this manuscript.

I am grateful to all the teachers who taught me during the years I spent in school, first in Palestine, then in Iraq and finally in the Unites States. I would like to thank Dr. Saleh Al-Araji for encouraging and inspiring me to pursue graduate studies.

Finally, I would like to express my deep gratitude to my brothers who have encouraged and inspired me and sponsored my undergraduate and graduate studies. I am extremely fortunate to be so blessed. I am also extremely grateful to my mother,

sister and wife for their sacrifice, encouragement and patience. I also thank several of my friends who have helped me throughout my career.

November 15, 2003

ABSTRACT

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The increasing demand for voice and data capacity has been the primary motivation for cellular and PCS evolution. Cohere detection is the most power-efficient scheme that is capable of providing substantial improvement in system capacity over noncoherent and differentially coherent schemes. For this reason, reverse link coherent detection is being considered as the framework for third generation wireless communication systems. In mobile communications, however. rapid fading may preclude a good estimate of the channel phase required to achieve coherent demodulation. This may lead to serious degradation to system performance. This dissertation investigates the capacity and error-rate performance of coherent systems with imperfect carrier recovery. These systems are known as partially coherent systems.

Partially coherent systems have not received thorough investigation in the literature. Most of the previous work has been focused on the analysis of performance for BPSK over AWGN channels. Upper bounds on bit error probability have been

derived, but found to be very conservative for the range of carrier phase jitter variance of practical interest. The error performance for partially coherent QPSK has not received much attention. Furthermore, the performance of partially coherent systems over multipath fading channels with diversity has not been studied.

In this dissertation, several upper and lower bounds on the error performance of partially coherent systems are derived by the application of Jensen's inequality and the isomorphism theorem from the theory of moment spaces assuming that the carrier phase error could have either Tikhonov or Gaussian distribution. An analytical method based on Gram-Charlier series expansion is also developed for the computation of the error probability and signal-to-noise ratio distribution of partially coherent systems over fading channels with diversity.

The application of partially cohere systems for CDMA mobile cellular communication is also investigated. performance impairments due to thermal noise, multipath fading, multiple access interference and self-noise are included in the analysis. A design criterion for adding weak signals with equal gain combining is established when the multipath intensity profile is nonuniform.

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0.1 COMMONLY USED SYMBOLS AND NOTATION

Symbol	Description
$\mathbf{v}$	*Vectors* in *lowercase* bold
v_a	a-component of vector $\mathbf{v}$
$\mathbf{M}$	*Matrices* in *uppercase* bold
$M_{r,c}$	Entry in row r and column c of matrix $\mathbf{M}$
$\mathbf{m}_c$	*Vector* occurring in column c of matrix $\mathbf{M}$
$\mathbf{x}$	Generic 3-dimensional spatial coordinate
$\tilde{\mathbf{x}}$	Generic 3-dimensional spatial coordinate (expressed *homogeneously*)
$\mathbf{y}$	Generic 2-dimensionals image coordinate
$\tilde{\mathbf{y}}$	Generic 2-dimensional image coordinate (expressed *homogeneously*)
$\mathbf{u}$	Pixelized 2-dimensional image coordinate
$\tilde{\mathbf{u}}$	Pixelized 2-dimensional image coordinate (expressed *homogeneously*)
${}^{A}\mathbf{x}$	Generic 3-dimensional spatial coordinate in reference frame A
${}^{A}\tilde{\mathbf{x}}$	Generic 3-dimensional spatial coordinate (expressed *homogeneously*) in reference frame A
${}^{C}_{B}\tilde{\mathbf{M}}$	Change from of reference frame B to reference frame C
s	Normalizing factor applied to *homogeneous* vector $\tilde{\mathbf{v}}$ such that original $\mathbf{v} = s \cdot \tilde{\mathbf{v}}$ is recovered
${}^{D}\mathbb{S}$	Spatial reference frame D
$[\mathbf{x}]_\times$	Skew-symmetric matrix version of vector $\mathbf{x}$ used as *left*-operand in the *cross*-product such that $[\mathbf{x}]_\times \cdot \mathbf{y} = \mathbf{x} \times \mathbf{y}$
l	Epipolar line
$\mathbb{P}$	Ray (or *pencil*) of all possible vectors $\mathbf{x}$ where $\mathbf{x} = s \cdot \tilde{\mathbf{x}}$ for some value of s