Performance Analysis of Cooperative Relay Networks in Presence of Interference

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STATEMENT OF ORIGIN

I certify that the work in this thesis is my genuine work and that all sources of materials used for mathematical analysis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements of Doctor of Philosophy program.

All the works has been published in international journals and conferences during this PhD program. I also certify that this thesis contains no material which has been submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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Abstract

In the past decade, cooperative communication has emerged as an attractive technique for overcoming the shortcomings of point-to-point wireless communications systems. Cooperative relaying improves the performance of wireless networks by forming an array of multiple independent virtual sources transmitting the same information as the source node. In addition, when relays are deployed near the edge of the network, they can provide additional coverage in network dead spots. Interference in the network can also be reduced in cooperative communications systems as the nodes can transmit at lower power levels compared to equivalent point-to-point communications systems.

Optimum design of a cooperative network requires an accurate understanding of all factors affecting performance. In order to parameterize the performance of cooperative systems, this thesis introduces mathematical models for different performance metrics, such as symbol error probability, outage probability and random coding error exponent, in order to analytically estimate network capacity.

A dual-hop network is introduced as the most basic type of relay network. Random coding error exponent results have been obtained using this simple network model are presented along with corresponding channel capacity estimates based on the assumption of Gaussian input codes. Next, a general multihop network error and outage performance model are developed.

Detailed mathematical and statistical models for interference relay networks are presented. The basic statistical parameters, cumulative distribution function and probability density function for interference cooperative dual hop relay networks are derived and explored. A partial formulation for the random coding error exponent (RCEE) result is also presented.

Simulation results over Rayleigh and Nakagami-m fading channel models are included in each chapter for all of the selected performance metrics in order to

validate the theoretical analysis, under the assumption that channels are flat over the duration of one symbol transmission. These results are in close agreement with the predictions of the analytical models.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ACRONYMS

SINR	Signal to interference plus noise ratio
SNR	Signal to noise ratio
SEP	Symbol error probability
CSI	Channel state information
AF	Amplify and forward
DF	Decode and forward
CF	Compress and forward
S-R	Source to relay link
R-D	Relay to destination link
PDF	Probability density function
CDF	Cumulative distribution function
MGF	Moment generating function
QOS	Quality of service
MRC	Maximal ratio combining
RCEE	Random coding error exponent
MIMO	Multiple input multiple output
i.n.i.d.	Independent and non identically distributed

LIST OF SYMBOLS

$\mathcal{C}^{m\times n}$	A $m \times n$ matrix with complex elements
$\mathbb{P}\left(X\right)$	Probability of random variable X
$f_X\left(x\right)$	Probability density function of X
$F_X\left(x\right)$	Cumulative distribution function of X
$\Phi_X\left(s\right)$	Moment generating function of X
$\mathbb{E}_X\left(x\right)$	Statistical expectation over random variable X
$I\left(X;Y\right)$	Mutual information between random variables X and Y
$K_\nu\left(x\right)$	νth order modified Bessel's function of second kind
$H_{p,q}^{m,n}\left[x\middle\vert\begin{matrix}(a_p)\\(b_q)\end{matrix}\right]$	Fox-H function
$G_{p,q}^{m,n}\left[x\middle\vert\begin{matrix}(a_p)\\(b_q)\end{matrix}\right]$	Meijer-G function
$\Gamma\left(x\right)$	Euler's Gamma function
$\Gamma\left(a,x\right)$	The upper incomplete Gamma function
$\gamma\left(a,x\right)$	The lower incomplete Gamma function

DEDICATION

To my parents