

# PERFORMANCE ANALYSIS OF COOPERATIVE RELAY NETWORKS IN PRESENCE OF INTERFERENCE

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A dissertation submitted in partial fulfillment of  
the requirements for the degree of

Doctor of Philosophy

University of Technology, Sydney  
Faculty of Engineering and Information Technology  
Centre for Real-Time Information Networks

October 2012

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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.

## ACKNOWLEDGMENTS

At first, I would like to thank my supervisors Dr. Mehran Abolhasan, Dr Daniel R. Franklin and Professor Farzad Safaei for their supervision and support to complete this thesis. Without their motivation and direction I would not be able to finish the thesis in time.

I thank to Australian Research Council (ARC), the Faculty of Engineering and Information Technology and the graduate school, UTS for the grant and financial support to finish this thesis.

I would like to thank Hien Quoc Ngo, Linkping University, Linkping, Sweden for his time and fruitful discussions on mathematical problems related to this thesis.

# TABLE OF CONTENTS

	Page
Abstract . . . . .	ii
List of Figures . . . . .	viii
Chapter 1: Introduction . . . . .	1
1.1 Background . . . . .	1
1.1.1 Wireless Channels . . . . .	2
1.1.2 Cooperative Communication . . . . .	3
1.1.3 Wireless System Performance Measures . . . . .	4
1.2 Key Contributions . . . . .	7
1.3 Thesis Overview . . . . .	8
1.4 Published Works . . . . .	9
Chapter 2: Literature Review . . . . .	10
2.1 Cooperative Communications . . . . .	11
2.1.1 Resource Allocation and Relay Selection . . . . .	14
2.1.2 Random Coding Error Exponent . . . . .	18
2.2 Communication over Multiple Hops . . . . .	20
2.2.1 Multihop Series Relay Communication . . . . .	20
2.2.2 Multihop Multi-branch Relay Communication . . . . .	22
2.2.3 Opportunistic Relaying in Multihop Relay Communication . . . . .	24
2.3 Communication in Interference . . . . .	25
2.4 Summary . . . . .	30
Chapter 3: Cooperative Relay Network: Dual Hop Transmission . . . . .	32
3.1 System Model . . . . .	33
3.2 Performance Analysis: Error and Outage Probability . . . . .	36
3.3 Error Exponent . . . . .	37
3.4 Ergodic Capacity . . . . .	40
3.5 Numerical Results . . . . .	42

3.6	Discussion . . . . .	44
Chapter 4:	Multihop Relaying . . . . .	45
4.1	Introduction . . . . .	45
4.2	System Model . . . . .	46
4.3	SEP and Diversity Analysis: Rayleigh Fading Channels . . . . .	47
4.4	SEP Analysis: Nakagami- $m$ Fading Channels . . . . .	51
4.5	Outage Analysis . . . . .	53
4.6	Numerical Results . . . . .	57
4.7	Discussion . . . . .	65
Chapter 5:	Relay Network in Interference . . . . .	66
5.1	Introduction . . . . .	66
5.2	System and Channel Model . . . . .	66
5.2.1	System Model 1: Interference at Relay . . . . .	68
5.2.2	System Model 2: Interference at Relay and Destination . . . . .	70
5.3	Statistical Analysis . . . . .	71
5.4	Interference at Relay: I.I.D. Nakagami- $m$ Interferers . . . . .	73
5.5	Outage Probability . . . . .	73
5.6	Error Exponent and Ergodic Capacity . . . . .	75
5.7	Numerical Analysis . . . . .	77
5.8	Conclusion . . . . .	83
Chapter 6:	Numerical Results and Discussion . . . . .	85
Chapter 7:	Conclusion . . . . .	90
Appendices	. . . . .	93
Appendix A:	. . . . .	93
A.1	<i>Proof of ordered <math>X_n</math></i> . . . . .	93
A.2	<i>Proof of the CDF of random sum</i> . . . . .	94
Appendix B:	. . . . .	95
B.1	<i>Proof of Theorem 5.1</i> . . . . .	95
B.2	<i>Proof of Theorem 5.2</i> . . . . .	96
B.3	<i>Proof of Proposition 5.1</i> . . . . .	97
B.4	<i>Proof of Proposition 5.2</i> . . . . .	98



Bibliography . . . . . 99

## LIST OF FIGURES

Figure Number	Page
2.1 User cooperation cooperative network. . . . .	10
2.2 Two-way relaying communication phase 1. . . . .	17
2.3 Two-way relaying communication phase 2. . . . .	17
2.4 Dual-hop cooperative relay network. . . . .	19
2.5 Multihop series relay network. . . . .	20
2.6 Multihop series relay network with diversity links. . . . .	21
2.7 Multihop multi-branch relay network with diversity link. . . . .	22
2.8 Interference in wireless network. Tx and Rx are the transmitter and the receiver respectively, and all other nodes on the plane are interfering nodes. The interferers inside the circle are the only active interferers that has sufficient transmission power to contribute in interference to the receiver Rx. . . . .	26
2.9 Dual hop relay network in presence of interference with diversity link. . . . .	28
3.1 Cooperative relay network without diversity link. . . . .	33
3.2 Random coding error exponent vs rate $R$ in nats/s/Hz with various total signal to noise power allocation. . . . .	42
3.3 Capacity (nats/s/Hz) vs total signal power to noise ratio in dB. . . . .	43
4.1 Multihop parallel relaying network. . . . .	46
4.2 Symbol error probability of multihop relay network as a function of total signal to noise power ratio in Rayleigh fading channels. . . . .	58
4.3 Symbol error probability of multihop relay network with the number of hops $N$ in Rayleigh fading channels. . . . .	58
4.4 Symbol error probability as a function of total signal to noise power ratio in Nakagami- $m$ fading channels with $m = 1, 2, 3, 4, 5, 6$ , and $\infty$ in a $[4, 4, 4, 4]$ network. . . . .	59
4.5 Symbol error probability of multihop parallel relay network with the number of parallel paths $K$ in a 4 hop network over Nakagami- $m$ fading channels with $m = 1, 2$ and $3$ . . . . .	60

4.6	Symbol error probability of a 4 path multihop parallel relay network as a function of the number of hops $N$ over Nakagami- $m$ fading channels with $m = 1, 2$ and $3$ . . . . .	61
4.7	Outage probability of 4 path multihop relay network as a function of total power in Nakagami- $m$ fading channels. . . . .	62
4.8	Outage probability of 4 path and 4 hop relay network as a function of power sharing coefficient $\xi$ with different SNR groups in Nakagami- $m$ fading channels. . . . .	63
4.9	Outage probability of 4 hop relay network as a function of number of relaying paths $K$ with different SNR groups in Nakagami- $m$ fading channels. . . . .	64
5.1	Interference relay network. . . . .	68
5.2	Outage probability vs total SNR in system model 1 and 2. . . . .	78
5.3	Outage probability vs total SNR in system model 2 with different level of INR's. . . . .	78
5.4	Outage probability vs total SNR in system model 2 with different number of interferers when INR=3 dB. . . . .	79
5.5	Outage probability as a function of total interferers at the relay and destination when the INR of each interferer is 3 dB. . . . .	79
5.6	Probability density function of SINR of system model 2. . . . .	80
5.7	Cumulative distribution function of SINR of system model 2. . . . .	80
5.8	Outage probability vs total SNR over Nakagami- $m$ faded interfering channels in system model 2 with different number of interferers. . . . .	81
6.1	Comparison of outage probability as a function of total transmit SNR of cooperative relay network with and without interference. . . . .	85
6.2	Outage probability as a function of total transmit SNR comparing multihop selective DF relay networks with dual hop hypothetical AF relay networks. . . . .	86
6.3	Outage probability as a function of total transmit SNR comparing multihop selective DF relay networks with dual hop interference network using hypothetical AF relay. . . . .	87
6.4	Outage probability as a function of interference power when the relay and the destination are subject to 4 interferers. . . . .	87

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

## DEDICATION

To my parents