IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 2 Issue 4, April 2015.
www.ijiset.com
ISSN 2348 – 7968

Performance Analysis of Dual-Hop Mixed Relaying Networks with N^{th} Best-Path Selection over Rayleigh Fading Channel

[1] Nivedha Mohan Sukanya Subramanian [2] Arunmozhi Sinouvassane [3]

[1] Dept. Of Electronics And Communication Engineering,
Manakula vinayagar institute of technology,
Pondicherry University,
Puducherry,India
nivedhaece.1992@gmail.com

[2] Dept. Of Electronics And Communication Engineering,
Manakula vinayagar institute of technology,
Pondicherry University,
Puducherry,India

[3] Dept. Of Electronics And Communication Engineering,
Associate Professor
Manakula vinayagar institute of technology,
Pondicherry University,
Puducherry,India

***Abstract*—Cooperative relaying is one of the promising technology which is used to improve coverage and spatial diversity. A new relay strategy, the N^{th} Best-Relay Selection scheme is proposed to improve the bandwidth penalty and to increase the spatial diversity by using a sub-optimal allocation for the relay relative distance between the source and destination in a multi-hop cooperative systems. A single branch dual-hop network and dual branch dual-hop network with adaptive Decode -and-forward (DF) and Amplify-and-forward (AF) cooperative diversity systems is considered. The proposed N^{th} Best-Relay selection scheme over single branch dual-hop system is compared with dual branch dual-hop network using the closed-form expression. The BER (Bit error rate) and Outage probability using binary and quadrature phase shift keying modulation schemes (BPSK & QPSK) with adaptive mixed decode-and-forward (DF) and amplify-and-forward (AF) cooperative diversity systems over Rayleigh fading channel were estimated. Results show that in the N^{th} best relay the diversity order is equal to (M −N +2) where M is the number of relays.**

IndexTerms*—Relay, N^{th}Best-Relay Selection scheme, single branch dual-hop network, dual branch dual-hop network, AF scheme, DF scheme

I. Introduction

Cooperative communication is one of the well-liked research titles which offer a better result to the battery life crisis by improving the transmission capacity and performance. Cooperative diversity can be defined as a numerous antenna technique proposed for reaching improved or increasing the whole network channel capacities intended for any specified set of bandwidths. This develops the user diversity through decoding of the grouped signal of which is a combination of relayed signal and the direct signal inside the wireless multi-hop networks.

An useful learning intended for the cause of computing the performance of the Multiuser diversity (MUD) cooperative wireless networks within the multiuser two-hop cooperative multi-relay networks by means of maximal ratio combining for both amplify-and-forward (AF) and decode-and-forward (DF) protocol has been done in [1].The multiuser diversity (MUD) cooperative wireless networks groups the characteristics of the MIMO (Multiple-in-multiple out), systems by not losing the physical layer limitation producing multiple copies of the transmitted signal from the source to the destination by the help of the relay node.

A detailed study on two relaying schemes has been done from [2-9]. Relaying schemes are mainly found of two types Namely, Amplify-and-forward (AF) and Decode-and-forward (DF). In the AF protocol, the signal from the source is received by the relay and then amplified. Thus the amplified signal will be sent at the destination. The performance of the Amplify-and-forward (AF) protocol was studied in detail [2-6].

In the DF protocol, after receiving the source signal, the relay performs the decoding, re-encoding, and sends the received signal to the destination. The performance of the Decode-and-forward protocol has a good literature [7-9].

In the first type, multi-hop cooperative systems with single branch (the result of best path selection through one antenna on the receiver plane) are considered, while in the other type, the

ISSN 2348 – 7968

focus was made on the dual-hop transmissions with multi-branch relaying using (two among four relays on a particular period of time and one of the branches), for the best relay selection over Amplify-and-forward (AF) protocol and Decode-and-forward protocol [10-11].The average bit error rate (BER) study intended for multi-relay multi-branch through standard cooperative scheme was studied in [12].Here the assumption is made the each and every one of the relay uses the AF(Amplify-and-forward) method of relaying.

However, this replica utilizes the moment generation function (MGF) technique to calculate the BER and assumption is the maximal ratio combining (MRC) method used on the destination. Each and every combining methods at the destination employs maximal ratio combining with spatial diversity, attaining array gain was analyzed [13-15].

Analysis of amplify-and-forward and adaptive decode-and forward with the N^{th} best-relay cooperative diversity over Rayleigh fading channels was studied [16-17].Inside the best-relay selection scheme, the best relay among the set of M relays transmits the source signal towards the destination. On the other hand, suppose the best relay is busy the next or second, third or in general the N^{th} best relay is selected.

Therefore, in cooperative-diversity networks if there are M relaying nodes, M+1 channels are required, which gains a bandwidth penalty. The crisis of the inefficient use of the channel resources can be eliminated with the use of the best-relay selection method. In such a method, the ‘best’ relay node (the relay which offers the highest SNR on the destination) is chosen to retransmit the source signal towards the destination.

The best relay may be not vacant due to features like setting up phase or work load balancing situations. In such a situation the choice could be taken to make use of the second best relay or in general the N^{th} best relay. One more additional illustration on the performance of the N^{th} best relay required is on the estimation of the performance loss involved on the cooperative diversity network as the destination (or the source) commits an error in choosing the best relay.

The performance of N^{th} Best-Relay selection scheme using the closed-form expression of BER (Bit error rate) and Outage probability using a sub-optimal allocation for the relay relative distance was analyzed. A single branch dual-hop and dual branch dual-hop network with adaptive DF and AF cooperative diversity systems using BPSK and QPSK modulation schemes were considered.

The rest of the paper is organized as follows. The system model having M relays was discussed in section II. Section III discusses the performance evaluation of the N^{th} best relay selection scheme over the AF and DF Channels. The simulation performances were elaborated in the section IV and the conclusion is done in the section V.

II. System Model

The system model indicates, a source node (S) and a destination node (D) communicating over a channel through a flat Rayleigh fading coefficient ($Ћ_{S,D}$). Numerous potential relaying nodes Ri, (i= 1, 2, ··M) are selected for relaying. The relays cooperates and transmits the source signal towards the destination using the AF and DF schemes. The channel coefficients linking S(source) and ith Relay ($Ћ_{S,Ri}$) and among R_i and D ($Ћ_{Ri,D}$) are considered to be flat Rayleigh fading coefficients. Additionally, the coefficients as of S to D ($Ћ_{S,D}$), $h_{S,Ri}$ and $h_{Ri,D}$, are mutually-independent. The assumption made here, is with no some loss of generalization the additive white Gaussian noise (AWGN) terms on each links comprises zero mean and equal variance (N_0).

Mathematically representing, the received signal as of the source, on the destination $y_{S,D}(t)$ and on the relay $y_{S,Ri}(t)$ could be written as,

$$y_{S,D}(t)= Ћ_{S,D}\sqrt{e_s}\,s(t)+ \mathfrak{N}_{S,D}(t) \tag{1}$$

$$y_{S,Ri}(t)= Ћ_{S,Ri}\sqrt{e_s}\,s(t)+ \mathfrak{N}_{S,Ri}(t) \tag{2}$$

Where, e_s is the energy of the transmitted signal, s(t) is the transmitted symbol having unit energy and $\mathfrak{N}_{S,D}(t)$ and $\mathfrak{N}_{S,Ri}(t)$ are the AWGN combined with the received signals.

On the next time slot, the N^{th} best relay processes the received signal and regenerates the relayed signal s_r(st) and forwards it towards the destination. Thus, the received signal on the destination as of the N^{th} best relay is given by

$$y_{R_{sel},D}(t) = Ћ_{R_{sel},D}\sqrt{e_s}\,s_r(t) + \mathfrak{N}_{R_{sel},D}(t) \tag{3}$$

where, $\mathfrak{N}_{Rsel,D}(t)$ be the AWGN noise combined with the relay on the destination link (R_{sel} toD link).

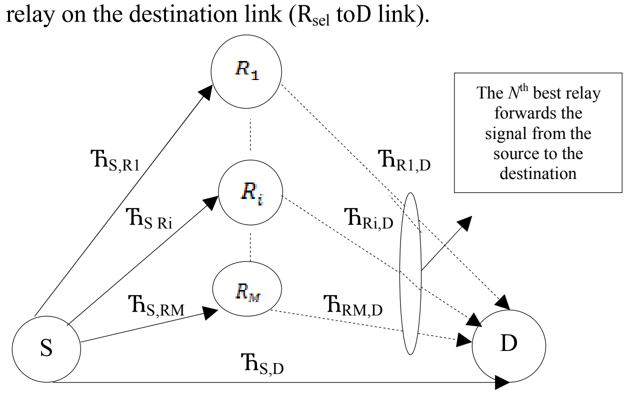

Fig 1. Illustration of the N^{th} best-Relay Selection Cooperative Diversity Network

A. *Error Probability*

To start analyzing the BER for the proposed model, it is mandatory to determine the value of the received SNR for the selected branch considering the sub-optimal allocation for the relay relative distance between source and destination and the attenuation factor. The Signal to noise ratio Y is given by,

$$\bar{Y}_{S,Ri} = \frac{E_S}{N_0}E[Ћ^2{}_{SRi}] = \frac{E_S}{N_0}\left(\frac{\Delta_{SD}}{\Delta_{SRi}}\right)^a \tag{4}$$

ISSN 2348 – 7968

$$\bar{\gamma}_{Ri,D} = \frac{E_s}{N_0} E\left[\hbar^2{}_{Ri,D}\right] = \frac{E_s}{N_0}\left(\frac{\Delta_{SD}}{\Delta_{Ri,D}}\right)^{a} \quad (5)$$

where, Δ_{SD}- Distance between source and destination channel
$\Delta_{S,Ri}$- Distance between source to relay channel
$\Delta_{Ri,D}$- Distance between second relay to destination
$\bar{\gamma}_{SD}$- Signal power of source to destination channel
$\bar{\gamma}_{S,Ri}$- Average Signal-to-noise power of source to relay
$\bar{\gamma}_{RDi}$- Average Signal-to- noise power of second relay to destination channel
a- Attenuation factor (dB)

To evaluate the performance of single branch multi-hop wireless network in terms of the BER performance metric considering the sub-optimal allocation for the relay relative distance between source and destination the following eq. (6) and (7) are considered.

$$p_{rS,Ri}(\text{é}) = A\left(1 - \sqrt{\frac{\bar{\gamma}_{S,Ri}B}{1+\bar{\gamma}_{S,Ri}B}}\right) \quad (6)$$

$$p_{rRi,D}(\text{é}) = A\left(1 - \sqrt{\frac{\bar{\gamma}_{Ri,D}b}{1+\bar{\gamma}_{Ri,D}B}}\right) \quad (7)$$

where, $p_{rS,Ri}(\text{é})$- Bit error probability of source and relay channel.

$p_{rRi,D}(\text{é})$- Bit error probability of second relay to destination channel of first and second branch.

B. Proposed Model

A novel cooperative-diversity network by means of simple dual hop virtual diversity by mixed decode-and forward and amplify-and-forward with N^{th} best path selection is considered.

A dual-hop dual-branch cooperative network is given in Fig.2, where S is the source node, D is the destination node, and the relay $R_{i,j}$ is the j^{th} relay in the i^{th} branch. Moreover, it is assumed that there is no direct link between S and D nodes . The communication performed in the proposed model is a type of virtual selection combining through best path selection lying on the destination. Here, the selection is made based on a feedback bit to put one of the branches reside on working state and the other keeps on hold off state awaiting for a acknowledgement from the destination when it is turned on. Furthermore, the proposed model is examined beneath slow-flat Rayleigh fading channels on behalf of each pair of source-to-relay, relay-to-relay, and relay-to-destination routes. Moreover, each and every link (S-R, R-R, R-D) can be assumed to include additive white Gaussian noise (AWGN) terms having equal variances N_o.

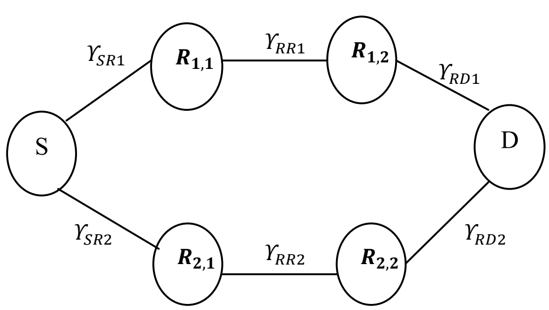

Fig. 2. Dual-Hop Dual-Branch Cooperative Network

In the proposed model, the relay selection protocol utilizes two among four relays at a particular period and one of the branches. In order to minimize the complication of the mathematical study, either all branch employs two relays operational on the N^{th} best relay selection on DF relaying method, or the first relay utilizes the AF method and the other is assumed to use DF relaying method .

The changeover of the dual branches is because of comprising one bit feedback by the destination (i.e., say' 1' for toggle state and '0' for hold states). The state of the receiver to forward the feedback toggling bit is a method of evaluation of the signal-to-noise ratio (SNR) on the output of the receiver, sometimes outage probability, or the BER.

$$\bar{\gamma}_{SR1} = \frac{E_s}{N_0} E\left[\hbar^2{}_{SR1}\right] = \frac{E_s}{N_0}\left(\frac{\Delta_{SD}}{\Delta_{SR1}}\right)^{a} \quad (8)$$

$$\bar{\gamma}_{RR1} = \frac{E_s}{N_0} E\left[\hbar^2{}_{RR1}\right] = \frac{E_s}{N_0}\left(\frac{\Delta_{SD}}{\Delta_{RR1}}\right)^{a} \quad (9)$$

$$\bar{\gamma}_{RD1} = \frac{E_s}{N_0} E\left[\hbar^2{}_{RD1}\right] = \frac{E_s}{N_0}\left(\frac{\Delta_{SD}}{\Delta_{RD1}}\right)^{a} \quad (10)$$

$$\bar{\gamma}_{SR2} = \frac{E_s}{N_0} E\left[\hbar^2{}_{SR2}\right] = \frac{E_s}{N_0}\left(\frac{\Delta_{SD}}{\Delta_{SR2}}\right)^{a} \quad (11)$$

$$\bar{\gamma}_{RD2} = \frac{E_s}{N_0} E\left[\hbar^2{}_{RD2}\right] = \frac{E_s}{N_0}\left(\frac{\Delta_{SD}}{\Delta_{RD2}}\right)^{a} \quad (12)$$

$$\bar{\gamma}_{RR2} = \frac{E_s}{N_0} E\left[\hbar^2{}_{RR2}\right] = \frac{E_s}{N_0}\left(\frac{\Delta_{SD}}{\Delta_{RR2}}\right)^{a} \quad (13)$$

$$\gamma_{SRR1} = \frac{\gamma_{SR1}\gamma_{RR1}}{\gamma_{SR1}+\gamma_{RR1}+1} \quad (14)$$

$$\gamma_{SRR2} = \frac{\gamma_{SR2}\gamma_{RR2}}{\gamma_{SR2}+\gamma_{RR2}+1} \quad (15)$$

$$\bar{\gamma}_{SRR1} = \frac{\bar{\gamma}_{SR1}\bar{\gamma}_{RR1}}{\bar{\gamma}_{SR1}+\bar{\gamma}_{RR1}+1} \quad (16)$$

$$\bar{\gamma}_{SRR2} = \frac{\bar{\gamma}_{SR2}\bar{\gamma}_{RR2}}{\bar{\gamma}_{SR2}+\bar{\gamma}_{RR2}+1} \quad (17)$$

Where, Δ_{SD} is the distance between source and destination channel, $\Delta_{SR1}, \Delta_{SR2}$ is the distance between source to first relay and second relay of first and second branches, $\Delta_{RR1}, \Delta_{RR2}$ is the distance between first relay to second relay of first and second branches, $\Delta_{RD1}, \Delta_{RD2}$is the distance between second relay to destination of first and second branches, $\bar{\gamma}_{SD}$ is the Signal power of source to destination channel, $\bar{\gamma}_{SR1}, \bar{\gamma}_{SR2}$-is the average Signal-to-noise power of source to first relay and second relay of first and second branches, $\bar{\gamma}_{RR2}, \bar{\gamma}_{RR1}$ is the Average Signal-to- noise power of first relay to second relay of first and second branches, $\bar{\gamma}_{RD1}$,$\bar{\gamma}_{RD2}$ is the average signal-to- noise power of second relay to destination of first and second branches, $\gamma_{SRR1}, \gamma_{SRR2}$is the signal-to-noise power of second relay of first and second branches and $'a'$ is the Attenuation factor (dB)

$$p_r(\Upsilon_{RD1} > \Upsilon_{RD2}) = \frac{A}{2}\left(1 - \sqrt{\frac{\bar{\Upsilon}_{RD}B}{1+\bar{\Upsilon}_{RD}B}}\right) \quad (18)$$

$$p_b(\Upsilon_b) = p_r(\Upsilon_{RD1} > \Upsilon_{RD2})p_{r1}(é) + p_r(\Upsilon_{RD2} > \Upsilon_{RD1})p_{r2}(é) \quad (19)$$

$$p_{r1}(é) = p_{rSRR1}(é)p_{X1}(é) + (1 - p_{rSRR1}(é))p_{rRD1}(é) \quad (20)$$

$$p_{r2}(é) = p_{rSRR2}(é)p_{X1}(é)p_{X2}(é) + (1 - p_{rSRR2}(é))p_{rRD2}(é) \quad (21)$$

Where, A and B are the coefficients that determine the modulation scheme,

$p_b(\Upsilon_b)$ – Sum of all error sources due to the usage of multi-hop with multi-branch transmission,

$p_{X1}(é)$=$p_{X2}(é)$ - Error probability with worse case value,

$p_r(\Upsilon_{RD1} > \Upsilon_{RD2})$ -Probability to facilitate the SNR Υ_{RD1} to be greater than γ_{RD2} that means selecting the first branch for transmission,

$p_r(\Upsilon_{RD2} > \Upsilon_{RD1})$ - Probability to facilitate SNR Υ_{RD2} to be greater than Υ_{RD1} that means selecting the second branch for transmission.

III. PERFORMANCE ANALYSIS

The average error probability above the slow flat fading channels can be obtained by averaging the conditional error probability on AWGN, where Υ is a common notation to stand for the instantaneous SNR of the method below is considered. The closed-form expression for the error probability for Rayleigh fading channels for both single branch and dual branch multi-hop networks is given by Eq. 22,

$$p_s^N(é) = A\left[1 - \sqrt{\frac{B_{\bar{\Upsilon}S,D}}{B_{\bar{\Upsilon}S,D}+1}}\right]\sum_{i=1}^{N}\{\sum_{S_i}\prod_{l=1}^{i-1}(1-D_{jl})\prod_{l=i}^{M}D_{jl}\} + A\sum_{q=1}^{M}\frac{1-D_q}{\bar{\Upsilon}_q}\sum_{\substack{i_1,i_2,\ldots i_{M-1}\\ satisfyingP}} \times$$

$k=0M-N(-1)k1\leq\Omega1<\Omega2<\ldots\Omega k\leq M-N\xi k1\varpi k+\Upsilon S,D1-\varpi k\Upsilon S,Db\Upsilon S,D1+b\Upsilon S,D-1\varpi k1-\varpi k\Upsilon S,DBB+\varpi k$ (22)

Where, $p_s^N(é)$ –Symbol error probability of the N[th] best relay for single branch multi-hop cooperative network, S_i– No. of source symbols transmitted, M – Total no. of relays, N – N[th] best relay, ϖ_k–Weight coefficient of S-R-D channel, ξ_k– Reliability coefficient and D_{jl}–Error function. The Complementary error function can be given by eq. 23.

$$D_i = A\int_0^{\infty} erfc(\sqrt{B\Upsilon})\, f_{\bar{\Upsilon}_{S,Ri}}(\Upsilon)d\Upsilon = A\left[1 - \sqrt{\frac{B\bar{\Upsilon}_{S,Ri}}{B\bar{\Upsilon}_{S,Ri}+1}}\right] \quad (23)$$

Where, D_i- is the complementary error function, a & b- are the error coefficients that determines the modulation scheme, (a=1/2,b=1 for BPSK modulation) and (a=1/2,b=1/2 for QPSK modulation).

A. Outage Probability analyses

The outage probability (p_{out}^N) is defined as the probability in which the mutual information of the channel (I=((1/2) $\log_2$(1 + ϒ)), falls below the required rate ρ. The 1/2 factor is meant for the requirement of two orthogonal channels or two time slots to transmit the data.

Therefore, for the N[th] best-relay selection cooperative diversity networks, the outage probability p_{out}^N can be given as,

$$p_{out}^N(x) = p_r((1/2)\log_2(1+\Upsilon)\leq\rho) = p_r(\Upsilon\leq 2^{2\rho}-1) \quad (24)$$

$$x = 2^{2p} - 1 \quad (25)$$

$$p_{r}{}_{out}^{N}(x) = A\left[1 - exp\left(\frac{-x}{\gamma_{S,D}}\right)\right]\sum_{i=1}^{N}\{\sum_{S_i}\prod_{l=1}^{i-1}(1-$$

$Djl)l=iMDjlAq=1M1-Dq\Upsilon qi1,i2,\ldots iM-1satisfying$
$P\times k=0M-N(-1)k1\leq\Omega1<$
$\Omega2<\ldots\Omega k\leq M-N\xi k\varpi k1+\varpi k\Upsilon S,D1-\varpi k\Upsilon S,D$
$-1\varpi k1-\varpi k\Upsilon S,Dexp-x\Upsilon S,D- \quad 11-\varpi k\Upsilon S,D \quad exp-x\varpi k$
(26)

where, $p_s^N(é)$- Symbol error probability of the N[th] best relay for single branch multi-hop cooperative network, S_i– No. of source symbols transmitted, M – Total no. of relays, N – N[th] best relay, ϖ_k–Weight coefficient of S-R-D channel , ξ_k– Reliability coefficient, D_{jl}– Error function, x- Channel state information transmitted at the transmission rate ρ (bp/Hz), $\bar{\Upsilon}_q$ – Average Signal-to-noise power of S-R_i-D channel (i=1,2...N), $p_{out}^N(x)$- Probability of outage ,A & B – coefficients.

B. Amplify and forward relay

In the amplify-and-forward method, the relayed signal (s_r) is an amplified version of the received signal $y_{S,Rsel}$ and can be given as s_r= $Gy_{S,Rsel}$,where, G=$\sqrt{es}$ /(E_sЋ$^2_{S,Rsel}$ + N_0) is the gain factor. The amplifier gain is selected to based on the fading coefficient Ћ$_{S,Rsel}$, so that the chosen relay can calculate by peak accuracy. It is broadly known that the accurate and upper bound of the overall SNR on the destination can be given as

$$\bar{\Upsilon}_i = \frac{\bar{\Upsilon}_{S,Ri}\bar{\Upsilon}_{Ri,D}}{\bar{\Upsilon}_{S,Ri}+\bar{\Upsilon}_{Ri,D}} \quad (27)$$

C. Decode and forward relay

In DF scheme, the source signal is transmitted to the set of M-relaying nodes and the destination node. The decoding set (C) is explored as the set of relays having the capacity to completely decode the source message properly i.e.., the relay node is supposed to present on the decoding set offered that the channel in between the source and the relay node is adequately fine to permit for successful decoding.

$$\bar{\Upsilon}_i = \bar{\Upsilon}_{Ri,D} \quad (28)$$

ISSN 2348 – 7968

On the second time slot, the N^{th} best-relay from the decoding set C transmits the source signal towards the destination. Later, the destination joins the direct and the N^{th} best indirect link by means of maximum ratio combining (MRC) method.

The performance of the N^{th} best relay selection for dual branch multi-hop cooperative network using BPSK and QPSK modulation with adaptive decode and forward and amplify and forward networks are analyzed in terms of performance metric BER and outage probability for various values of M and N are simulated and it is found that as M increases, the diversity order also increases and as N increases, the diversity order linearly decreases furthermore the diversity order equals to M–N+2 and the error probability is minimized with increase in spatial diversity.

IV. SIMULATION RESULTS

The BER performance of the N^{th} best relay selection scheme for M= 4 and different values of $N$and for N= 2 and different values of M at medium and high SNR values for both BPSK and QPSK modulations on AF relaying system was simulated and the results shows that as M increases the diversity order increases and as N increases the diversity order decreases respectively and finally the diversity order equals to M-N+2 .

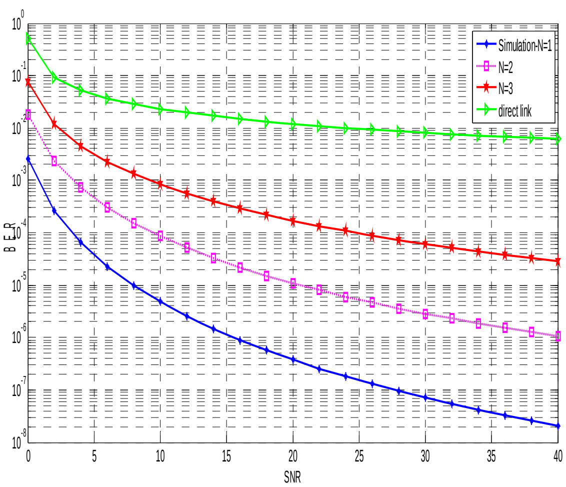

Fig.3.SNR Vs. BER for M=4 and N= 1,2,3 over AF system using BPSK modulation.

Fig.3 depicts, the BER performance of the N^{th} best relay selection scheme for M= 4 and different values of Nat medium and high SNR values for BPSK modulations on AF relaying system was simulated and the results shows that N=1(best relay) and as N increases the diversity order decreases respectively and finally the diversity order equals to M-N+2.

Fig.4 depicts, the BER performance of the N^{th} best relay selection scheme for M= 4 and different values of Nat medium and high SNR values for QPSK modulations on AF relaying system was simulated and the results shows that N=1(best relay) and as N increases the diversity order decreases respectively and finally the diversity order equals to M-N+2 and the error probability increases for higher order modulation (i.e..,) Error probability of BPSK is better than QPSK modulation.

Fig.5 depicts, the BER performance of the N^{th} best relay selection scheme for N=2 and different values of Mat medium and high SNR values for BPSK modulations on AF relaying system was simulated and the results shows that as M increases the diversity order increases respectively and finally the diversity order equals to M-N+2.

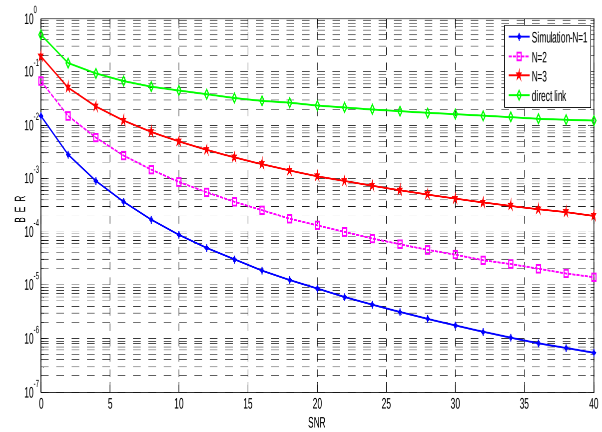

Fig.4. SNR Vs. BER for M=4 and N= 1,2,3 over AFsystem using QPSK modulation.

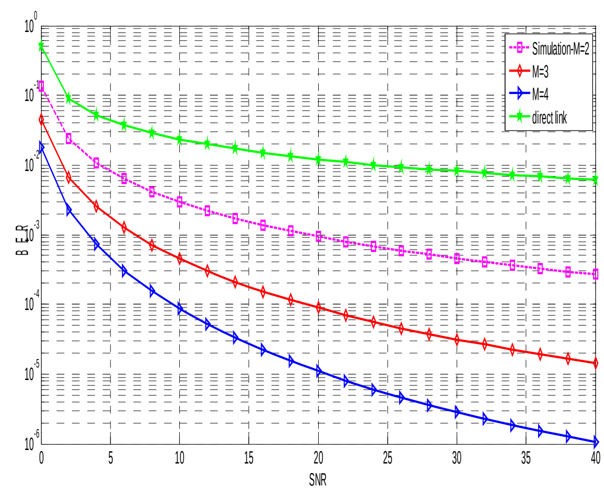

Fig.5 SNR Vs. BER for N=2 and M= 2,3,4 over AF system using BPSK modulation.

The BER performance of the N^{th} best relay selection scheme for M= 4 and different values of $N$and for N= 2 and different values of M at medium and high SNR values for both BPSK and QPSK modulations on DF relaying system was simulated and the results shows that as M increases the diversity order increases and as N increases the diversity order decreases respectively and finally the diversity order equals to M-N+2.

ISSN 2348 – 7968

Fig.6 depicts, the BER performance of the N^{th} best relay selection scheme for M= 4 and different values of Nat medium and high SNR values for BPSK modulations on DF relaying system was simulated and the results shows that N=1(best relay) and as N increases the diversity order decreases respectively and finally the diversity order equals to M-N+2 .

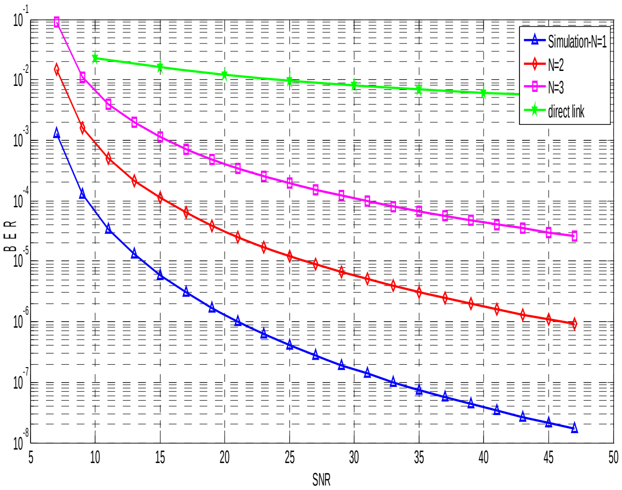

Fig.6 SNR Vs. BER for M=4 and N= 1,2,3 over DF system using BPSK modulation.

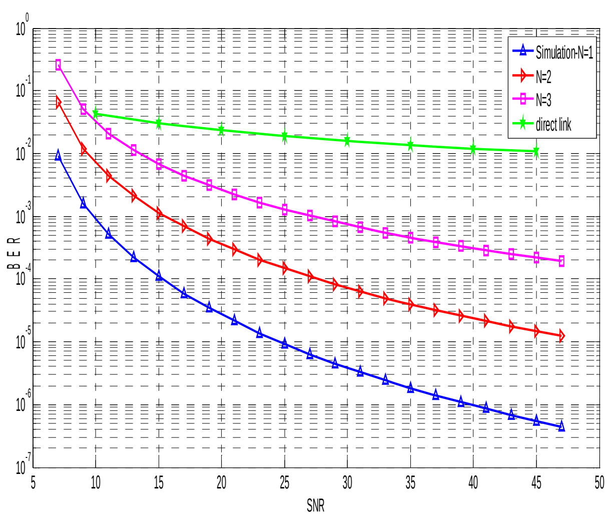

Fig.7 SNR Vs. BER for M=4 and N= 1,2,3 over DF system using QPSK modulation.

Fig.7 depicts, the BER performance of the N^{th} best relay selection scheme for M= 4 and different values of Nat medium and high SNR values for QPSK modulations on DF relaying system was simulated and the results shows that N=1(best relay) and as N increases the diversity order decreases respectively and finally the diversity order equals to M-N+2 and the error probability increases for higher order modulation (i.e..,) Error probability of BPSK is better than QPSK modulation.

Fig.8 depicts, the BER performance of the N^{th} best relay selection scheme for N= 2 and different values of Mat medium and high SNR values for BPSK modulations on DF relaying system was simulated and the results shows that as M increases the diversity order increases respectively and finally the diversity order equals to M-N+2.

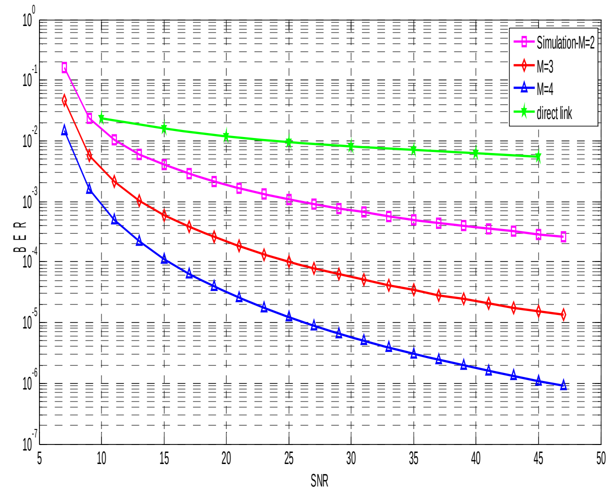

Fig.8 SNR Vs. BER for N=2 and M= 2,3,4 over DF system using BPSK modulation.

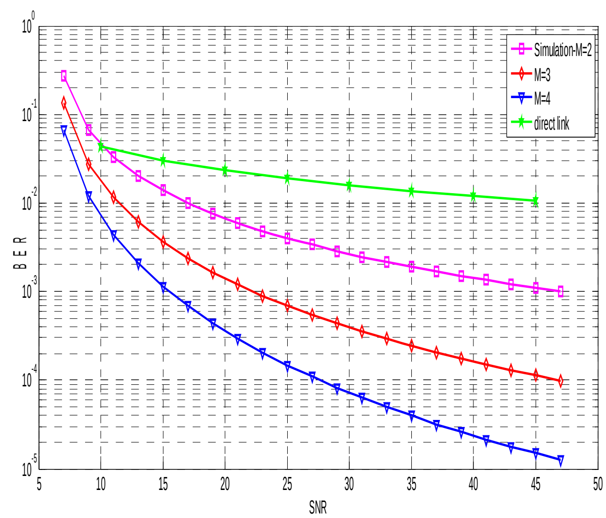

Fig.9 SNR Vs. BER for N=2 and M= 2,3,4 over DF system using QPSK modulation.

Fig.9 depicts, the BER performance of the N^{th} best relay selection scheme for N=2 and different values of Mat medium and high SNR values for QPSK modulations on DF relaying system was simulated and the results shows that as M increases the diversity order increases respectively and finally the

ISSN 2348 – 7968

diversity order equals to M-N+2 and the error probability increases for higher order modulation (i.e..,) Error probability of BPSK is better than QPSK modulation.

The outage probability performance of the N^{th}best relay selection scheme for M= 4 and different values of Nat medium and high SNR values for both BPSK and QPSK modulations on AF relaying system was simulated and the results shows that as N increases the diversity order decreases respectively and finally the diversity order equals to M-N+2 .

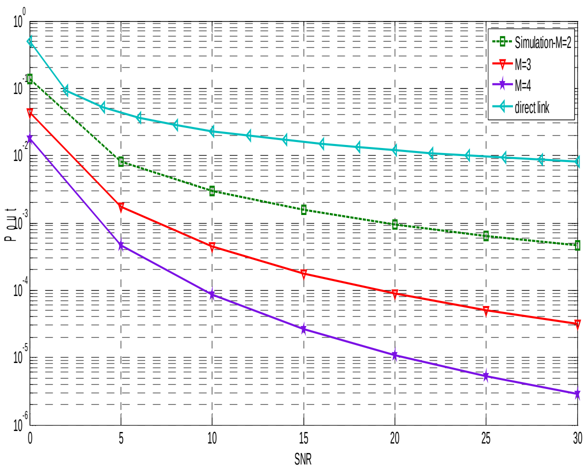

Fig.10 Eb/N0 Vs. Outage Probability for M=4 and N= 1,2,3 over AF system using BPSK modulation

Fig.10 depicts, the outage probability ($Pout$) performance for r = 1 bit/sec/Hz of the N^{thv}best relay selection scheme for M= 4 and different values of at medium and high SNR values for both BPSK on AF relaying system was simulated and the results shows that N=1(best relay) and as N increases the diversity order decreases respectively and finally the diversity order equals to M-N+2.

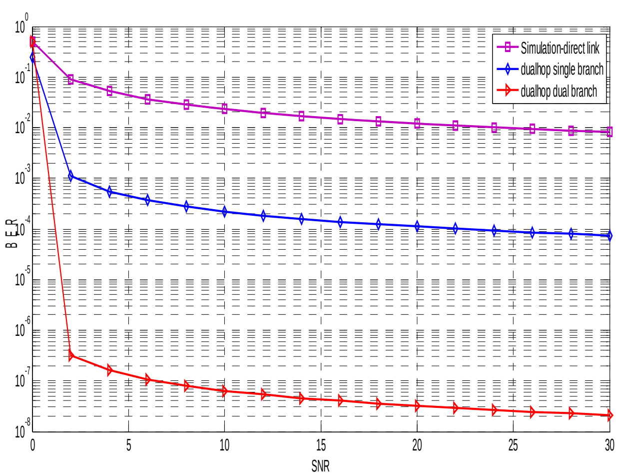

Fig.11 SNR Vs. BER for Single and dual-hop branch using BPSK modulation.

The dual-hop dual-branch mixed relaying cooperative networks with best-path selection. Closed-form expression for the BER of the proposed model is derived assuming slow Rayleigh .fading channels with binary and quadrature phase shift keying modulation schemes. The results show that the proposed model outperforms the regular cooperative network models whereas a sub-optimal allocation for the relay relative distance was extensively studied .The BER versus SNR considering the relative sub-optimal distance between the source to relay, relay to relay, relay to destination and source to destination.

Fig.11 depicts, that the BER performance for any value of SNR of dual -hop branch is better than the single branch multi-hop network using BPSK modulation, whereas a sub-optimal allocation for the relay relative distance is assumed.

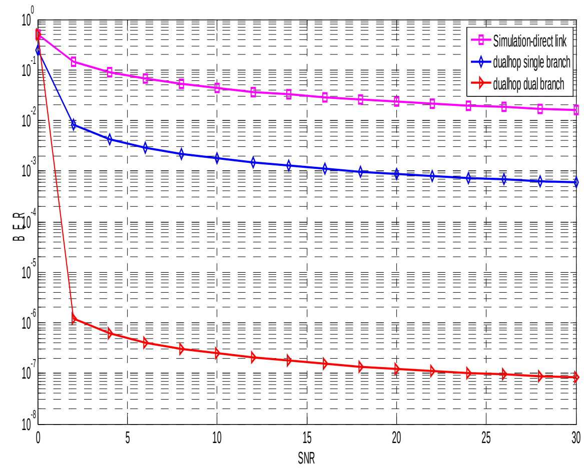

Fig.12 SNR Vs. BER for Single and dual-hop branch using QPSK modulation.

Fig.12 depicts, that the BER performance for any value of SNR of dual -hop branch is better than the single branch multi-hop network using QPSK modulation and BER performance of BPSK is better than QPSK modulation.

V. CONCLUSION

The complete performance analysis of the N^{th} best-relay selection scheme for any SNR value in a multi-hop cooperative systems with single branch using BPSK and QPSK modulation for Amplify and Forward and Decode and Forward system was done in terms of Bit error probability and Outage probability for different values of M and N relays considering relative distance between source and relay. Results shows that as the number of relays increases the diversity order increases M-N+2 and as N^{th} best relay increases the diversity order decreases and (N=1) is found to be the best relay . Furthermore, the results shows the comparative analysis of error probability of dual hop branch and single branch multi-hop networks indicating the

ISSN 2348 – 7968

error probability of dual hop branch is better than the single branch multi-hop networks. Further, the performance of the N^{th} best relay selection scheme can be further extended over dual-hop networks with other relaying strategies using higher order modulation.

References

[1] MuawiahHlayel, Ali M. Hayajneh, Mamoun F. Al-Mistarihi, Mohammad Shurman, and Khalid A. Darabkh, "Closed-form Expression of Bit Error Rate in Dual Hop Dual-Branch Mixed Relaying Cooperative Networks with Best-Path Selection over Rayleigh Fading Channels*",* IEEE Transactions on Wireless Communications,pp . 4799-3866, Jul. 2014.

[2] J. Hu, and X. Chen, "Symbol Error Probability and Channel Capacity for Multiuser Diversity of Amplify-and-Forward Cooperative Networks," in Proc. of 7th International Conference on Wireless Communications, Networking and Mobile Computing (WiCOM 2011), Wuhan, China, pp. 1- 4, Sept. 2011.

[3] C. N. Beaulieu, and S. S. Soliman, "Exact Analysis of MultihopAmplifyand- Forward Relaying Systems over General Fading Links," IEEE Transactions on Communications, vol. 60, issue 8, pp. 2123-2134, Aug. 2012.

[4] M. Seyfi, S. Muhaidat, and L. Jie, "Amplify-and-Forward Selection Cooperation over Rayleigh Fading Channels with Imperfect CSI," IEEE Transactions on Wireless Communications, vol. II, issue I, pp.199 - 209, Jan. 2012.

[5] N. S. Ferdinand, and N. Rajatheva, "Unified Performance Analysis of Two-Hop Amplify-and-Forward Relay Systems with Antenna Correlation," IEEE Transactions on Wireless Communications, vol. I 0, issue 9, pp. 3002 - 3011, Sept. 2011.

[6] L. Y. Phee M. Elkashlan, C. Zhuo and 1. B. Collings, "SER of Multiple Amplify-and-Forward Relays with Selection Diversity," IEEE Transactions on Communications, vol. 59, issue 8, pp. 2078 - 2083, Aug. 2011.

[7] X. Rui, 1. Hou, and L. Zhou, "Decode-and-forward with full-duplex relaying," International Journal of Communication Systems, vol. 25, issue 2, pp. 270-275, Feb. 2012.

[8] X. Rui, "Decode-and-forward with partial relay selection," International Journal of Communication Systems, vol. 23, issue II, pp. 1443-1448, Nov. 2010.

[9] W. Xu, 1. Lin, K. Niu, and Z. He, "Error performance for relaying protocols with multiple decode-and-forward relays," International Journal of Communication Systems, vol. 23, issue 8, pp.1016-1040, Aug. 2010.

[10] M. O. Hasna and M-S. Alouini, "Outage probability of multi-hop transmission over Nakagami fading channels," IEEE Communications Letters, vol. 7, no. 5, pp. 216-218, May 2003.

[11] D. B. Costa and S. Aissa, "End-to-end performance of dual-hop semi blind relaying systems with partial relay selection," IEEE Transactions on Wireless Communications, vol. 8, no.8, pp. 4306-4315, Aug. 2009.

[12] Amir H. Forghani, Salama S. Ikki and Sonia Aissa, "Novel Approach for Approximating the Performance of Multi-Hop Multi-Branch Relaying over Rayleigh Fading Channels," in Proc. of 2011 IFIP Wireless Days (WD), Niagara Falls, ON, pp.I-3, Oct. 2011.

[13] F. S. AI-Qahtani, S. A Zummob, A K. Gurung, and Z. M. Hussain, "Spectral efficiency of maximum ratio combining (MRC) over slow fading with estimation errors," Digital Signal Processing, ElseVier, vol. 20, issue I, pp. 85-96, Jan. 2010.

[14] P. M. Shankar, "Maximal ratio combining in independent identically distributed n nakagami fading channels," lET Communications, vol. 5, issue 3, pp. 320-326, Feb. 2011.

[15] P. M. Shankar, "Maximal Ratio Combining (MRC) in Shadowed Fading Channels in Presence of Shadowed Fading Co-channel Interference (CCI)," Wireless Personal Communications, vol. 68, issue I, pp. 15-25, Jan. 2013.

[16] Salama S. Ikki, Member, IEEE, and Mohamed H. Ahmed, Senior Member, "On the Performance of Cooperative-Diversity Networks with the *N*th Best-Relay Selection Scheme", IEEE transactions on communications, vol. 58, no. 11, Nov. 2010.

[17] S. S. Ikki and M. H. Ahmed, "Performance analysis of adaptive decode-and- forward cooperative diversity networks with the best relay selection scheme," IEEE Trans. Communications., vol. 58, no. 1, pp. 68-72, Jan. 2010.

Nivedha Mohan received the B.TECH degree in Electronics and communications Engineering from, Pondicherry University , Puducherry, on April 2013, respectively.Currently she is pursuing M.TECH. degree in Pondicherry University, Puducherry from September 2013 and will be completing by May 2015.Her major research interests are cooperative communications, modulation and coding techniques, and combining technique. She has published 4 papers in international journals in the same area. She is a Member of Students IETE Forum.

Sukanya Subramanian received the B.TECH degree in Electronics and communications Engineering from, Pondicherry University , Puducherry, on April 2013, respectively. Currently she is pursuing M.TECH. degree in Pondicherry University, Puducherry from September 2013 and completing by May 2015. She has published 4 papers in international journals in the wireless communication.

Arunmozhi Sinouvassane received the Bachelors Degree in Electronics and Communication Engineering from Pondicherry University on May 2000. He completed his Masters degree in Electronics and Communication Engineering from Pondicherry University on February 2002. He is working as Associate Professor in ECE department of Manakula vinayagar institute of technology, Pondicherry, India. He is pursuing research in the area of wireless communication. He has published 6 papers in international journals and 15 national and international conferences in the same area.