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Performance Analysis of Various Relay Selection Schemes in Rayleigh, Rician and Nakagami Fading Channels with Parallel AF Relays

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Abstract: Relay selection technique has great importance in the performance of cooperative networks. Therefore, relay selection gained the attention of researchers. The relay selection techniques SCR, SR and ASR have already been proposed to enhance the outcome of cooperative networks. In this paper, we implement these relay selection schemes on dual hop cooperative network. We used amplify and forward relaying scheme and analyzed the performance of each relay selection scheme over rayleigh, rician and nakagami fading channels. Bit Error Rate (BER) are considered as a metric for performance analysis. All the simulations were carried out using Monte Carlo Simulation in Matlab.

Keywords: Cooperative Networks, Relaying schemes, Relay selection schemes, Nakagami Fading channel, Rician Fading Channel,

1. INTRODUCTION

In future wireless communication, high data rate and large coverage area can be achieved by cooperative network. In cooperative network, relays are used to forward the data from source to destination (Nosratinia *et al*., 2004). To forward the data, the main relaying protocols used in cooperative network are "Amplify and Forward" (AF), "Decode and forward" (DF), "Compress and Forward" (CF), "Estimate and Forward" (EF) and "Coded Cooperation" (Nosratinia *et al.,* 2004), (Tanoli *et al.,* 2013). But if all the relays start forwarding the data, it will increase the interfering sources, bit error rate, power consumption, data traffic and decrease bandwidth efficiency. For N-number of relays, the required channels will be N+1 without relay selection (Salama and Ahmad, 2010), Song, 2011), (Jing and Jafarkhani, 2007), (Nam *et al*., 2008). Many researchers (Tanoli *et al.,* 2013), (Lin and Erkip, 2005), (Bletsas *et al*., 2005) worked on relay selection and improved the performance as well as the utilization of channel resources in cooperative diversity network by introducing relay selection (RS) schemes in which only best relay(s) will forward the data to destination. The authors in (Won *et al*., 2007) proposed two relay selection schemes based on instantaneous channel gain. In first one, among K number of available relays, only M number of relays having good channel gain will forward the data. In second one, authors used threshold to minimize the number of forwarding relays and required channels. The authors in (Lin and Erkip, 2005) suggested relay selection based on instantaneous SNR and number of antennas in relay. Further, the authors in (Jing and Jafarkhani, 2007) showed that same diversity gain can be obtained by consuming less power and proposed relay selection schemes based on power constraint in which that relay will forward the data to destination which consume less power. For DF relaying, the author in (Salama and Ahmad, 2010) derived the exact closed form general expression for the outage probability and average channel capacity for cooperative diversity network using best relay selection with Adaptive Decode and Forward Relaying which is valid for any SNR value. Decreasing the number of forwarding relay does not decrease the outage probability (Salama and Ahmad, 2010).

The authors in (Ibrahim *et al*., 2008) introduced another relay selection scheme in which only one best relay is selected on the basis of channel gain. Then the authors in (Adinoyi, 2007) proposed three relay selection schemes i.e. "Selection Cooperative Relaying" (SCR), "Selection Relaying" (SR) and "All Path Selection Cooperating Relaying" (ASR). In these RS schemes, relay selection is based in instantaneous SNR. The number of required channels are one or two depending on relay selection scheme. The performance of these RS schemes have been analyzed over Rayleigh fading channel using DF relaying scheme.

In this paper, we implement the three RS schemes proposed in (Adinoyi, 2007) on dual hop cooperative network with parallel AF relays, over Nakagami, Rician and Rayleigh fading channels. The authors in (Adinoyi, 2007) did not analyze the performance of these RS schemes in different fading channels and AF relaying scheme. In this paper, we presented its performance using AF relaying forwarding scheme over Nakagami, Rician and Rayleigh fading

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channel. Performance analysis of these RS scheme is carried out using Monte Carlo simulation in Matlab taking BER (Bit error rate) as a metric. Maximal Ratio Combining (MRC) technique is used to retrieve the source data at destination. Thus the objective to this paper is to analyze the performance of these three RS schemes in different fading channels using "Amplify and Forward" relaying scheme.

2. MATERIAL AND METHODS

System Model

The system investigated in this paper is shown in **(Fig. 1)**. Our system model consist of source, destination and N-numbers of relays. Source is denoted by 'S', destination by 'D' and relays by R_i (i = 1, 2, 3…N). Single antenna is mounted on each node. Here the assumed fading channels are Nakagami, Rician and Rayleigh. For simplicity, it is assumed that fading does not change during transmission. Each path is independent of each other. α_0 represents instantaneous SNR value of source to destination link. α_{s-ri}, α_{ri-d} denote the instantaneous SNR value of $S-R_i$ and R_i-S links respectively.

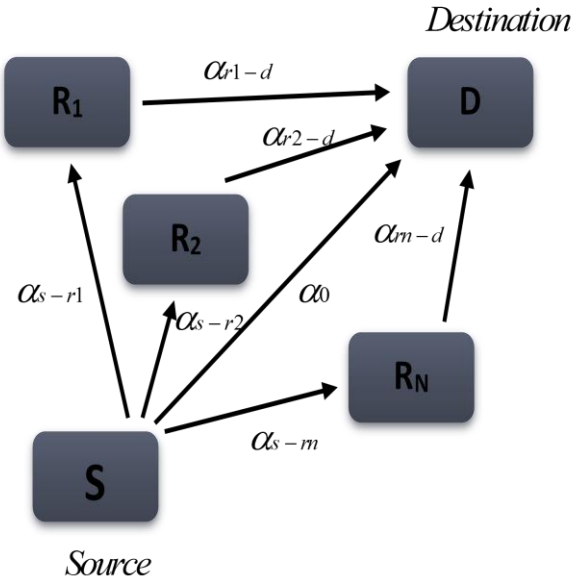

Fig. 1: Dual Hop Cooperative Network

During transmission, AWGN (Additive White Gaussian Noise) is added in signal. In the dual hop cooperative network, the source transmits the signal in first hop and all relays listen. In the second hop, the best relay is selected on the metric of instantaneous SNR value and that relay will amplify the signal and forward it to destination. Decision of best relay is carried out at destination. Note that relay are not allowed to communicate with each other.

Review of SCR, SR and ASR Relay Selection Schemes

A. Selection Cooperative Relaying (SCR)

In SCR, the signal is transmitted to destination by direct path and by selected best relay. At destination, the signal received through direct path and indirect path is combined using Maximal Ratio Combining (MRC). Therefore, the combine SNR is the sum of two SNRs. The criteria for selecting best relay is the relay which maximize the minimum SNR of the two links (S-R, R-D).

$$Best\ \text{Relay} = \max\{\min(\alpha_{s-ri}, \alpha_{ri-d})\}$$

where i = 1, 2, 3…..N

B. Selection Relaying (SR)

In Selection Relaying, it is assumed that deep fading occur in direct path. Therefore, the direct path is not used to transmit the signal. Signal is transmitted to destination only through best relay. Here no MRC is used because there is only one signal received to destination. The criteria for selecting best relay is same as previous.

C. All-Path Selection Cooperating Relaying (ASR)

In All-Path Selection Cooperating Relaying, the signal is transmitted to destination through only one path. Either through direct path or indirect path depending on the values of their instantaneous SNR. Destination selects only one path in available N+1 paths. The advantage of ASR is that the destination does not have to perform MRC so ASR system is less complex than SCR. The criteria of selecting best path is, first the best relay is selected on the previous rules, then the signal is transmitted by that relay if the minimum instantaneous SNR of that relay's link (S-R,R-D) is greater than instantaneous SNR of S-D link otherwise the S-D path will be selected.

$$Best\ \text{Path} = \max\{\min(\alpha_{s-r}, \alpha_{r-d}), \alpha_0\}$$

Where α_{s-r} and α_{r-d} are instantaneous SNR values of S-R and R-D links of best relay.

3. RESULTS AND DISCUSSION

The system model shown in previous section is simulated taking N =2. Results are discussed in this section. BER is the metric used to show the performance of each relay selection scheme in different fading channels using AF parallel relays.10^6 number of symbols have been simulated to plot the BER curves **(Fig 2, 3, 4)**. BER analysis **(Fig. 2)** shows the performance of SCR relay selection scheme in Rayleigh, Nakagami and Rician fading channels. As obvious from figure.2 SCR shows better performance in Nakagami and Rician channels. Note that the value of 'm' is equal equal to 5 for rician fading channel. At low

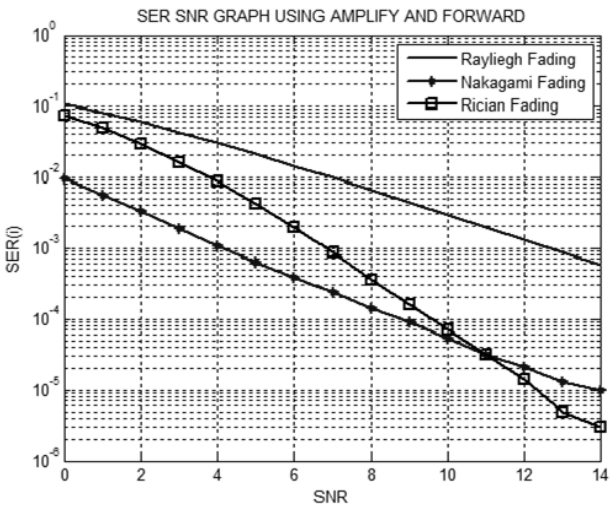

Fig.2: Performance analysis of SCR relay selection scheme in Rayleigh, Nakagami and Rician Fading Channels

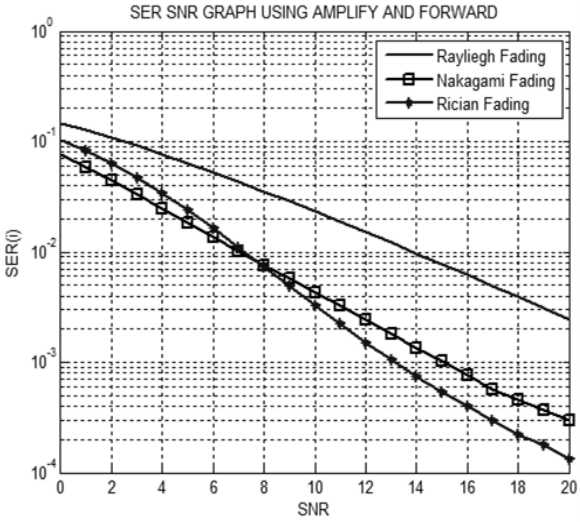

Fig.3:Performance analysis of SR relay selection scheme in Rayleigh, Nakagami and Rician Fading Channels

to 3 for nakagami fading channel and the value of 'k' is SNR, the performance is better in Nakagami channel and at high SNR, the SCR shows good performance in Rician fading channel. The performance of SR relay selection scheme is shown in **(Fig. 3).** As clear from figure that SR scheme shows poor performance in Rayleigh fading channel and shows good performance in Nakagami at low SNR and Rician fading channel at high SNR value. BER analysis of ASR relay selection scheme is shown in **(Fig. 4)**. According to our simulation results, the difference in the performance of ASR scheme in rician, nakagami fading channel is small. nakagami fading channel is small. At low SNR, better performance is observed in nakagami fading channel and in rician fading channel at high SNR

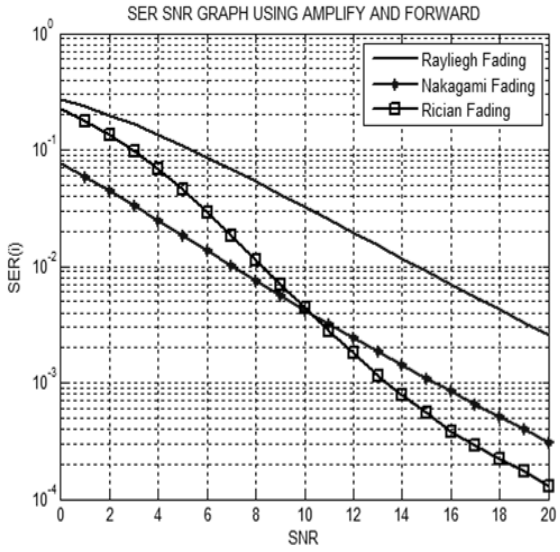

Fig.4: Performance analysis of ASR relay selection scheme in Rayleigh, Nakagami and Rician Fading Channels

4. CONCLUSION

In this paper, we presented the performance of three relay selection schemes SCR, SR and ASR. The performance is analyzed using AF parallel relays over rayleigh, rician and nakagami fading channels. We presented all the results in form of BER versus SNR curves. According to our simulation result, all relay selection schemes show high BER in Rayleigh fading. We observe low BER in Nakagami fading channel at low SNR value and low BER in rician fading channel at high SNR value. In future, we will implement these relay selection schemes using estimate and forward relaying protocol.

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