# MODIFICATION OF MULTIPLE ANTENNA AMPLIFY AND FORWARD RELAY OVER NAKAGAMI FADING CHANNEL

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**ABSTRACT**

Acceptable Quality of Service (QoS) without increasing the transmitter power is of paramount importance in wireless communication system. However, QoS is affected by wireless channel leading to unreliable reception. Multiple Antenna Amplify and Forward Relay (MAAFR) previously used to address this problem, is associated with hardware complexity, long signal delay that results in long processing time and signal distortion. Hence, this paper addresses a Modified Multiple Antenna Amplify and Forward Relay (MMAAFR) over the Nakagami fading channel. MMAAFR model is developed using three fixed gain relays, modified Maximal Ratio Combiner (MRC) at Radio Frequency (RF) stage. The MMAAFR model is incorporated into a system model which consists of transmitter, Nakagami channel and receiver. The transmitter consists of randomly generated data used as source data, encoded and modulated using M-ary Phase Shift Keying (M-PSK) schemes. The modulated signals are then passed through a Nakagami fading channel. The faded signals are received by the three relays. The relays amplify the received signals with a fixed gain and forward the processed version to the modified MRC. The modified MRC combines the received signals. The system model is evaluated using the Outage Probability (OP) which is derived from the received signal using the Probability Density Function (PDF), Bit Error Rate (BER) and Processing Time (PT). The results obtained show that MMAAFR gives lower OP, BER, and PT values than MAAFR. Therefore, the paper shows hardware complexity reduction in MAAFR and MMAAFR can be used in wireless communication by network designer.

**Keywords**: Amplify and Forward relay, Nakagami channel, Multiple Antenna, MPSK, modified MRC

## 1 INTRODUCTION

Wireless communication is the process of transferring information from one location to another in space. The information may be analogue, digital and hybrid. Wireless communication finds application in biometrics, medical, bank, military and so on, these make the wireless service to increase on daily basis. However, the wireless systems performance is affected by multipath propagation and path loss due to many obstacles along the propagation path. Multipath propagation occurs when multiple copies of the transmitted signal are propagating over the channel and received by the receiver due to mechanisms such as scattering, reflection, refraction of the transmitted signal causing the received signal to be fluctuating. The fluctuation of the received signal may be below the sensitivity of the receiver, thereby degrading the system performance. In wireless communication, channels are stastically modeled by many distributions such as Rician fading, Rayleigh fading, lognormal fading, Nakagami fading. However, in this paper, Nakagami fading channel is used because of its closeness to experimental data in terrestrial environment [4, 10, 13].

Though, the distorted signal has been mitigated by different methods such as equalization technique, adaptive modulation or adaptive power control technique, multicarrier technique, diversity technique and so on, but the most appropriate method for solving signal fading is diversity technique which can be in different categories such as space diversity, time diversity, frequency diversity and so on. In this paper, space diversity is being considered under which cooperative relay technique is an example. Cooperative relay technique uses multiple antennas with relay systems situated between the transmitter and receiver. This technique has helped in increasing the signal strength without increasing the transmitted power [1]. The relay in turn is used to receive signal from the transmitter and guide it to the receiver. There are different techniques to obtain cooperative relay namely Decode and Forward (DF) relay, Compressed and Forward (CF) relay, Amplify and Forward (AF) relay. Decode and Forward (DF) relay decodes the received signal from the transmitter, modulates without any amplification and then forwards it to the receiver [5]. While AF relay amplifies the received signal from the transmitter, without any decoding, then forwards the amplified version of the processed signal to the receiver [4, 6, 13, 16]. According to

[7], AF is classified as variable gain and fixed gain relay. The variable gain requires knowledge that represents the state of communication link known as Channel State Information (CSI) while fixed gain relay requires partial CSI [3, 8, 12]. Though, some of the existing cooperative relays may be enhanced with combining diversity techniques such as Equal Gain Combiner (EGC), Maximal Ratio Combiner (MRC) but at the expense of overlapping of signals and hardware complexity that result in longer processing time. Hence, there is need to have or employ model that will have low hardware complexity and can still improve the quality of signal without increasing the transmitted power. Therefore, this paper addresses a modified Multiple Antenna (MA) relay model to reduce hardware complexity and overlapping of signal in the conventional multiple antenna AF relay model. The modification of existing multiple antenna relay is carried out over Nakagami fading channel using multiple antenna amplify and forward relay with three fixed gain relays. The outputs of the relays are combined using a modified MRC with single Radio Frequency (RF) chain and single Matched Filter (MF) at the receiver [19, 20]. The closed loop expression for the received signal of the modified model using the Probability Density Function (PDF) is derived. The model is simulated using MATLAB simulation software and evaluated using Bit Error Rate (BER), Outage Probability (OP) and Processing Time (PT).

## 2 MULTIPLE ANTENNA AMPLIFY AND FORWARD RELAY MODEL

In multiple Antenna Amplify and Forward Relay, the transmitter communicates with the receiver through direct $h_{BM}$ and relay transmissions. The relays amplify the received signals over $h_{Br1}, h_{Br2}, h_{Br3}$ and then retransmit the amplified version of the signals to the receiver. The signals from different relays are combined using MRC indicating many Radio Frequency (RF) chains and many Matched Filters (MF) leading to many hardware components. The net effect of this technique is the delay among the relays and direct path which may result in high delay at the receiver. The high delay causes signal distortion in addition to signal fading. The model is shown Figure 1.

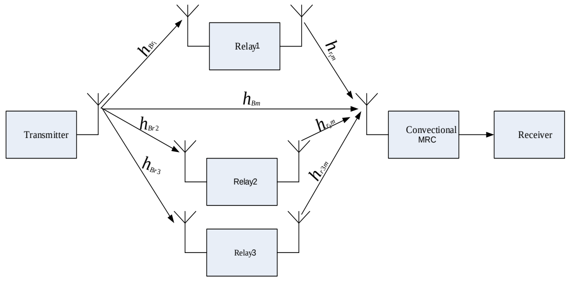


Figure 1: Conventional Amplify and Forward (AF) relay

### 2.1 Average Signal to Noise Ratio

Signal to Noise Ratio (SNR) is one of the easiest performance metrics used in wireless digital communication system. It is measured at the output of the receiver and gives the overall fidelity about the system. This metric is mostly used to determine the level of thermal noise present in the output of signal subjected to fading impairment, where the term "average" is the statistical measure over the probability distribution of the fading. Thus, the expression for average signal to noise ratio '$\breve{\Upsilon}_{AV}$' is given by [17] as

$$\breve{\Upsilon}_{AV} = \int_0^{\infty} \Upsilon_{SN} P_{\Upsilon}(\Upsilon_b) dy \qquad (1)$$

where: $\breve{\Upsilon}_{AV}$ is the average signal to noise ratio,
$P_{\Upsilon}(\Upsilon_b)$ is the probability density function of output signal to noise ratio

### 2.2 Outage Probability

This is defined as the probability that the instantaneous end to end Signal to Noise Ratio falls below a given corresponding value of predefined threshold. However, predefined threshold is computed by determining the Probability Density Function (PDF) of end to end signal. Thus, the expression for Outage Probability (OP) is given by [17] as

$$OP = \int_0^{\Upsilon_0} P_{\Upsilon_b}(\Upsilon) dy \qquad (2)$$

where $OP$ is the outage probability,
$P_{\Upsilon_b}$ is the probability density function of output signal to noise ratio,
$\Upsilon_0$ is the predefined threshold.

### 2.3 Bit Error Rate

Bit Error Rate (BER) is another performance metric used in evaluating the system performance. Data transmitted over a channel have the possibility of introducing error into the system, thus, if this occurs, the integrity of the system is degraded. As a result, it is very important to assess the performance of the system and BER gives an accurate approach in which this can be achieved. According to [18], BER is expressed in a transmission system as

$$\text{BER}=\frac{number\ of\ \ bits\ in\ error}{total\ number\ of\ bits\ \ transmit} \quad (3)$$

## 3 PHASE SHIFT KEYING

Phase Shift Keying (PSK) uses a finite number of phases with each of phase assigned to a unique pattern of binary digit. Each phase encodes an equal number of bits, thus each bit pattern forms the symbol represented by the particular phase. The symbol set used by the modulator is designed for the demodulator to determine the phase of the received signal and maps it back to the symbol that represents the original data. This requires the receiver to be able to compare the phase of the received signal to a reference signals, thus, such system is referred to as Coherent Phase Shift Keying.

### 3.1 Binary Phase Shift Keying

Binary Phase Shift Keying (BPSK) is the simplest form of Phase Shift Keying. The phase of a carrier signal switches between two binary data that is, 0 and 1. The two signals are separated in phase by 180°, thus, it is termed: 2-PSK or BPSK.

### 3.2 Quadrature Phase Shift keying

Quadrature Phase Shift keying (QPSK) is a PSK modulation scheme that uses four phases to encode two bit per symbol. The phases of the carrier are represented with four points on the constellation diagram, equispaced around the circle.

## 4 Nakagami-m Fading

Nakagami-m fading is a statistical model or distribution used to describe the presence of scattering object in the channel that causes no line of sight and a dominant component of radio signal. Hence, this distribution has the best fit to terrestrial, indoor-mobile and clustered environment [17]. Thus, PDF (N) for Nakagami-m fading is given by [17] as

$$\text{PDF}(N) = \left(\frac{2m^{m}r^{2m-1}}{\Gamma(m)2\sigma^{2m}}\right) exp\left(-\frac{mr^2}{2\sigma^2}\right) \quad N \geq 0 \quad (4)$$

where :‘m’ is shape factor of the nakagami distribution that ranges from 0.5 to ∞, when ‘m’ equal ‘1’ gives Rayleigh fading.
Then, when ‘m’ is greater than ‘1’ gives Rician fading
‘Γ’ is the Gamma function,
$\sigma^2$ is the ratio of power of line of sight component to average power of the scattered component,

### 4.1 Frequency Selective Fading

Frequency selective fading occurs when the root mean square (rms) delay is greater than the symbol length of the digital modulation. Thus, the received symbols through different paths extend beyond the symbol time. This results in overlapping of signal leading to Inter Symbol Interference (ISI) distortion.

### 4.2 Maximal Ratio Combining

Maximal Ratio Combining (MRC) method was first developed by (Kahn 1954). This method is carried out by weighting each signal from each of the all branches and later sum. However, each signal must be in common phase before being summed together, in order to avoid signal constellation. Hence, if each branch has a gain $(\alpha_i)$ then, the resultant signal ‘ $r_N$ ’ is given by [9] as

$$r_N = \sum_{k=1}^{N} \alpha_k r_k \quad (5)$$

where: ‘N’ is the number of branches,
$\alpha_k$ is gain in $k^{th}$ branches,
$r_k$ is the received signal from $k^{th}$branches

Also, if each branch has the equal noise power in each branch, then the resultant noise power at the combiner output is given by [11] as

$$N_{Total} = N \sum_{k=1}^{N} \alpha^2{}_k \quad (6)$$

where: $N_{Total}$ is the total noise power from all branches,
N is the number of branches,
$\alpha^2{}_k$ is the gain of $k^{th}$ branch

Hence, the Probability Density Function (PDF) of the MRC output is given by [11] as

$$PDF_{MRC} == \frac{1}{N-1}\frac{{\gamma_t}^{N-1}}{{\gamma_{AV}}^{N}}\ exp\left(-\frac{\gamma_t}{\gamma_{AV}}\right)\ \gamma_t > 0 \quad (7)$$

where: $\gamma_{AV}$ is the average SNR at each diversity branch,
$\gamma_t$ is the SNR ratio at the output of the MRC
N is the number of paths

## 5 Conventional Amplify and Forward Relay

[14] used amplify and forward relay with fixed gain to increase the network coverage area and improve the quality of service on wireless communication system. The transmitter communicates with the receiver through direct and relay transmission. Hence, the received signals $D(t)$ from the transmitter at both receiver and the relay otherwise known as the first hop transmission is given by [14] as

$$D(t) = h_o s(t) + n_o(t) \quad (8)$$
$$R(t) = h_{1,l} s(t) + n_1(t) \quad (9)$$

where : $D(t)$ is the received signal at the receiver,
$R(t)$ is the receiving signal at the relay,
$h_o$ is the fading distribution of the channel between the transmitter and receiver,
$h_{1,l}$ is the fading distribution of the channel between the transmitter and the relay,
$s(t)$ is the transmitted signal,
$n_o(t)$ is the Additive White Gaussian Noise,
$n_1(t)$ is the Additive White Gaussian Noise at the relay,

Also, the transmitted signal from the relay to the receiver '$D_r$' otherwise known as second hop transmission is given by [14] as

$$D_r = \sum_{l=1}^{N} h_{2,i} G\left(h_{1,l} s(t) + n_1(t) + n_2(t)\right) \quad (10)$$

where: $D_r$ is the received signal at the receiver through the relay transmission,
G is the fixed gain,
$h_{2,i}$ is the fading amplitude of the channel between the relay and receiver,
$n_2(t)$ is the Additive White Gaussian Noise,

Hence, using Equations (8) and (9) the instantaneous end to end $\Upsilon_{MRC}$ at the receiver is given by [14] as

$$\Upsilon_{MRC} = \frac{|h_O|^2}{{\sigma_o}^2} + \sum_{l=1}^{N} \frac{\frac{|h_{1,i}|^2}{{\sigma_{1,i}}^2}\frac{|h_{2,i}|^2}{{\sigma_{2,i}}^2}}{\frac{|h_{2,i}|^2}{{\sigma_{2,i}}^2} + \frac{1}{{G_l}^2{\sigma_{1,i}}^2}} s(t) \quad (11)$$

where: $\frac{|h_{1,i}|^2}{{\sigma_{1,i}}^2}$ , $\frac{|h_{2,i}|^2}{{\sigma_{2,i}}^2} s(t)$ are the signal to noise ratio at the first hop,
$\frac{|h_{2,i}|^2}{{\sigma_{2,i}}^2}$ is signal to noise ratio at the second hop.
$\frac{1}{{G_l}^2{\sigma_{1,i}}^2}$ is the fixed gain of the relay.

Multiple Antennas is one of the essential techniques used in communication system. Antenna is a device that has the ability to transmit and receive signals at a given frequency. However, the efficiency of an antenna depends on its gain. Gain is the ratio of an antenna's capacity to transmit or receive power in a given direction relative to a standard known as isotropic antenna.
Multiple Input Multiple Output **(**MIMO) antenna is a technique that uses the same number of antenna at both the transmitter and receiver to improve the performance of communication system by using diversity and spatial multiplexing techniques. This system has been responsible for improving the quality of service without increasing the transmitter power. It has also provided higher spectral efficiency, improved resistance to interference and mitigates adverse channel effect such as fading [2, 15].

## 6 MODIFICATION OF MULTIPLE ANTENNA AMPLIFY AND FORWARD RELAY MODEL

The modification is carried out using reactive relay with three fixed gain relays and MRC with single RF chain and single MF. The relays are equipped with multiple antenna at both receiver and transmitter. The relays are independent of one another and received signals over Nakagami fading channel. The three antenna relays receive the transmitted signals, amplify and forward through the single RF chain and single MF. Hence, this modification is shown in Figure 2.

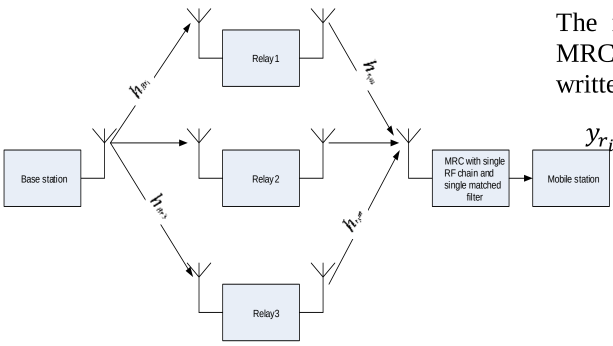


Figure 2: Modification of Multiple Amplify and Forward (AF) relay

### 6.1 Expression for the Received Signal for the Modified Model

In the first phase, the transmitter transmits stream of information to the relay through the orthogonal channel using Frequency Divisional Multiple Access (FDMA). The received signal $R(t)$ at the relay is given by [14] as:

$$R(t) = h_{1,l}s(t) + n_1(t) \qquad (12)$$

Equation (12) is modified as

$$y_{B,r_i}(t) = (P_t)^{\frac{1}{2}} h_{Br_i} Z_{Br_i} s(t) + n_{,r_i} \qquad (13)$$

where:

$y_{B,ri}$ (t) is the received signal at $i^{th}$ relay, for i= 1, 2 and 3,
s(t) is the transmitted signal,
$Z_{Br_i}$ is reflection that causes change in amplitude and phase of signal due to scattering
$P_t$ is the power at the transmitter,
$h_{B,ri}$ is Nakagami fading channel between the transmitter and relay,
$n_{,r_i}$ is thermal noise assumed to be Additive White Gaussian Noise (AWGN).

In the second phase, each of the three relays amplifies multipath received signals with a fixed gain, then retransmits the processed version to MRC with single RF chain single MF through orthogonal channel using Time Division Multiple Access (TDMA). The fixed gain G at relay is given by [1] as

$$G = \left(\frac{P_r}{P_r(|y_{sr}|^2)+n_r}\right)^{\frac{1}{2}} \qquad (3)$$

where:

$P_r$ is the relay power,
$y_{sr}$ is the received signal at relay,
$n_r$ is thermal noise assumed to be AWGN

The received multipath component signal at the MRC with single RF chain and single MF is written as:

$$y_{r_i m}=\sum_{i=1}^{3} G_i (P_{r_i})^{\frac{1}{2}} h_{r_i m} Z_{r_i m} y_{Br_i} + n_m \qquad (4)$$

where:

$y_{ri,m}$ is received signal at the MRC,
$P_{r_i}$ is the transmitting power at $i^{th}$ relay,
$Z_{r_i m}$ is reflection that causes change in amplitude and phase of signal due to scattering,
$h_{ri,m}$ is Nakagami fading channel between the $i^{th}$ relay and MRC with single RF chain and single matched filter channel,
$G_i$ is the fixed gain,
$n_m$ is thermal noise assumed to be AWGN

Using Equations (1)-(3) the combined multipath instantaneous SNR of the modified MRC is given as

$$\Upsilon_{MMRC} = \frac{\left(\frac{(P_t)^{\frac{1}{2}}|h_{Br_i}|}{n_{r_i}}\frac{(P_{r_i})^{\frac{1}{2}}|h_{r_i m}|}{n_m}\left(\frac{P_{r_i}}{P_{r_i}\left(|y_{Br_i}|^2\right)+n_{Br_i}}\right)^{\frac{1}{2}} s(t)\right)^{L-1}}{\hat{\Upsilon}^{L}(L-1)!} \times exp - \left(\frac{\frac{(P_t)^{\frac{1}{2}}|h_{Br_i}|}{n_{r_i}}\frac{(P_{r_i})^{\frac{1}{2}}|h_{r_i m}|}{n_m}\left(\frac{P_{r_i}}{P_{r_i}\left(|y_{Br_i}|^2\right)+n_{Br_i}}\right)^{\frac{1}{2}} s(t)}{\hat{\Upsilon}}\right) \qquad (5)$$

where: $\Upsilon_{MMRC}$ is output SNR of the MRC with single RF chain single matched filter,

$\frac{(P_t)^{\frac{1}{2}}|h_{Br_i}|}{n_{r_i}}$ and $\frac{(P_{r_i})^{\frac{1}{2}}|h_{r_i m}|}{n_m}$ are the instantaneous SNR for the received signal for the first phase and second phase respectively,

s(t) is the transmit signal,

$\left(\frac{P_{r_i}}{P_{r_i}\left(|y_{Br_i}|^2\right)+n_{Br_i}}\right)^{\frac{1}{2}}$ is the fixed gain for the relays,

$\breve{\Upsilon}$ is average SNR,
'L' is the number of paths

From Equation (5), the PDF output from the transmitter for the modified model is expressed as

$$PDF(\Upsilon_{MRC}) = \frac{1}{(L-1)!}\frac{\Upsilon_{MMRC}^{\ L-1}}{\overline{\Upsilon}_{AVMMRC}^{\ L}}exp\left(-\frac{\Upsilon_{MMRC}}{\overline{\Upsilon}_{AVMMRC}}\right) \quad (6)$$

where:

L is the number of paths,
$\Upsilon_{MMRC}$ is the total SNR output of the MRC with single RF chain and MF for the modified model
$\overline{\Upsilon}_{AVMMRC}$ is average SNR of the MRC with single RF chain and MF for the modified model.

### 6.2 Simulation model

The modified model is incorporated into a system model which consists of randomly generated data as source data, encoded, modulated using M-ary Phase Shift Keying (MPSK) schemes for ‘M’ at 2 and 4 indicating Binary PSK and Quadrature PSK signalling schemes, respectively. The modulated signal is properly filtered by Square Root Cosine (SRRC) filter before transmitting through the Nakagami fading channel, $Da_1$, $Da_2$, and $Da_3$ with AWGN; $Na_1$, $Na_2$, $Na_3$ added. The faded signals are received by the three antenna AF relays. The simulation model for the modified model is shown in Figure 3.

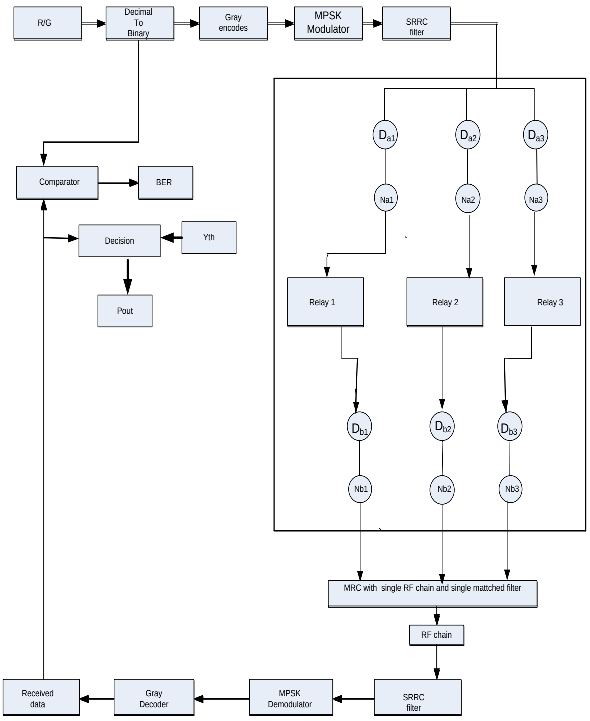


Figure 3: Simulation model for the modified multiple antenna amplify and forward relay

The three relays with fixed gains amplify the received signals and retransmit the processed version of the signal over the same channel. The received signals are combined at RF stage using the MRC with single RF chain and single MF for further processing and finally demodulated using MPSK demodulator after being gray decoded. The received/ decoded signal is compared with binary data transmitted to determine the BER, also compared with the threshold value to determine the outage probability. The processing time when conventional MRC and the modified are used is also determined. The simulation model is shown in Figure 3. The model is simulated using parameters contained in Table 1.

**Table 1: Simulation parameters for the modified model**

| Parameter | Type |
|---|---|
| Modulation schemes | BPSK, QPSK scheme |
| Channel | Nakagami-m |
| Noise | AWGN |
| Number of antenna at the relay | 3 |
| Carrier frequency | 1800MHz |
| Transmitter and Receiver filter | Square Root Raised Cosine |
| Combiner | MRC with single RF chain and single matched filter |
| Number of symbol (data length) | 20,000 |
| Number of samples | 4 |
| Set threshold | 2 dB |
| Bandwidth of symbol | 250kHz |
| Delay Spread time | 200ns |

## 7 RESULTS AND DISCUSSION

Figures 4- 9 present the results of the BER, OP versus SNR for the modified and conventional Multiple Antennas AF relay over Nakagami fading channel using M-PSK signaling schemes. Figure 4 depicts the Outage Probability (OP) versus SNR for the modified and conventional multiple antennas AF relay over Nakagami fading channel using 2-PSK known as schemes. The OP values obtained at SNR of 6 dB are $3.8125\times 10^{-5}$ and $2.68\times 10^{-2}$ for the modified and conventional 3 antenna AF relays respectively, while Figure 5 shows OP versus SNR for the modified and conventional three 3 antenna AF relay using QPSK scheme. It has been deduced that OP values obtained at SNR of 6 dB, are $4.1379\times 10^{-5}$ and $3.51\times 10^{-2}$ for the modified and conventional three (3) AF relays with conventional MRC and MRC with single RF chain and single MF. Fig. 6 reveals Bit Error Rate (BER) versus SNR for the three antennas AF relays using BPSK scheme. The BER values obtained at SNR of 6 dB is 0.0762 with the modified MRC at RF stage as against 1.6942 obtained with conventional MRC over the AF relays using BPSK scheme. Fig. 7 depicts the BER values obtained at different SNRs over the three (3) antenna AF relays in Nakagami fading channel. It can be confirmed that at SNR of 6 dB BER value obtained is 0.0678 with the modified MRC at RF stage as against 1.6216 obtained for conventional MRC over three (3) antenna AF relays with QPSK scheme. Fig. 8 shows the processing time (PT) at different SNRs for the modified and conventional MRC with the antenna AF relays using 2-PSK (BPSK) scheme. The PT values obtained using BPSK scheme at SNR of 6 dB are 1.3407 s and 3.4493 s for the modified MRC and conventional MRC with three (3) antenna relays, respectively as against 1.3527 s and 3.0635 s obtained using 4-PSK (QPSK) scheme for the modified and conventional MRC with three (3) antenna relays, respectively, presented in Fig. 9 The results obtained show that the modified Antenna Amplify and Forward Relays with the modified MRC at RF stage give lower OP, BER and PT values than the three (3) antenna AF Relays with three RFs, MF due to the use of reactive relay, single RF chain and MF. Also, the absence of the direct transmission from transmitter also eliminates the high delay which may occur when compared with the transmission through the reactive relays. As the constellation of the PSK increases, BER decreases and PT increases for both modified and conventional three (3) antenna Amplify and Forward relays. This is because of the number of bits per symbol transmitted.

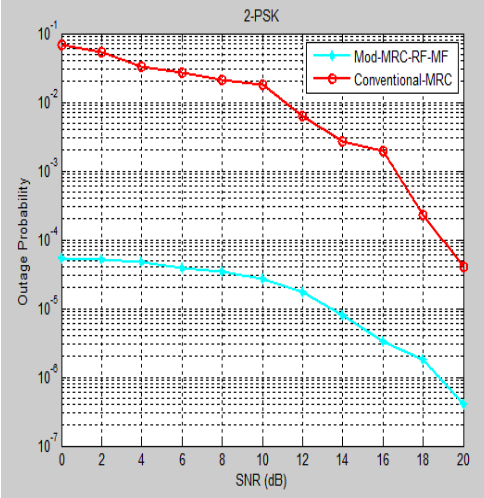


Figure 4: Outage Probability versus SNR for the modified and conventional 3 antenna AF relays model at 2-PSKsignaling schemes

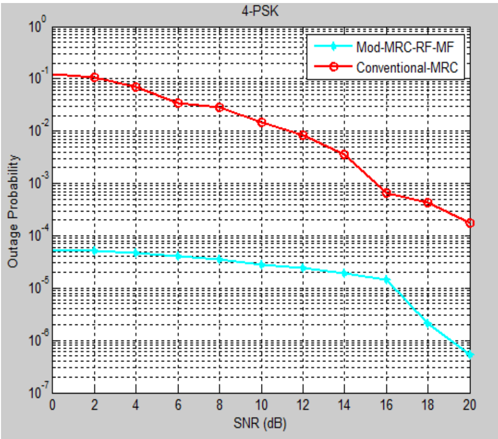


Figure 5: Outage Probability versus SNR for the modified and conventional 3 antenna AF relays model at 4-PSKsignaling schemes

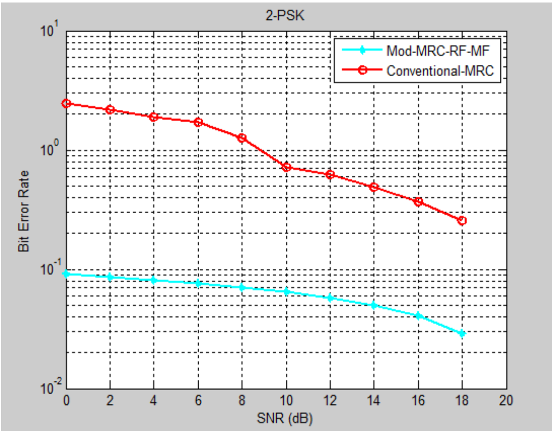


Figure 6: Bit Error Rate versus SNR for the modified and conventional 3 antenna AF relays model at 2-PSK signaling scheme.

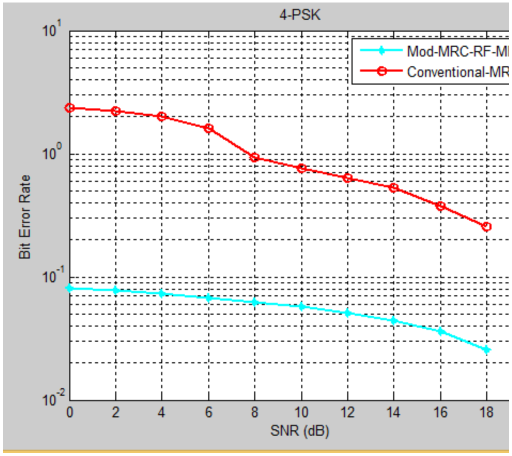

Figure 7: Bit Error Rate versus SNR for the modified and conventional 3 antennas AF relays model at 4-PSKsignaling schemes

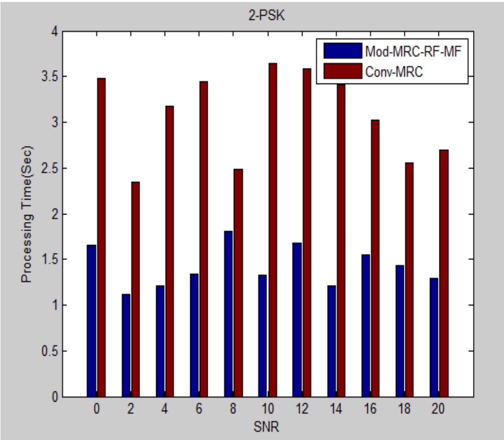

Figure 8: Processing time versus SNR for the modified and conventional 3 antennas AF relays model at 2PSKsignaling scheme

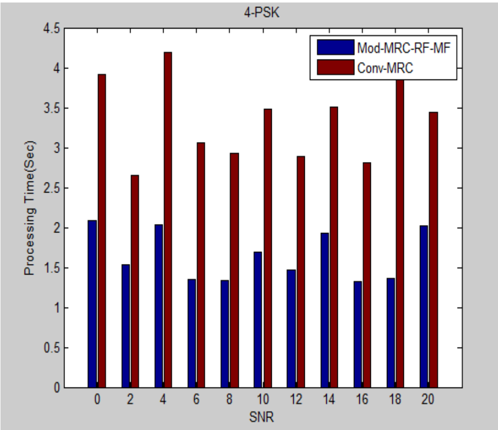

Figure 9: Processing time versus SNR for the modified and conventional 3 antennas AF relay model at 4-PSKsignaling schemes.

## 8 CONCLUSIONS

This paper has carried out the development of a modified Multiple Multiple Antenna Amplify and Forward Relay over Nakagami Fading channel. Three antenna amplify and forward relays over Nakagami fading channel using three fixed gain relays has been modified and enhanced by MRC with single RF and MF. The system model has also been developed around the modified model using M-PSK signal schemes. The closed form expression for the received signal of the modified model has been derived using PDF of the Nakagami Fading channel. The system model has been simulated using MATLAB simulation software and evaluated using OP, BER and PT to determine the performance. It has been shown that the modified model gives lower OP, BER and PT values than conventional model. Therefore, the paper has eliminated the overlapping of symbols that may increase the error due to distortion and has also shown the hardware complexity reduction.

**Reference**

[1] Liu, R, Sadek, A and Kwasinski A cooperatives communication and networking, Cambridge university, New York.pp 3-222. (2009)

[2] Yong, S.C, Jaekwon, K, Won, Y and Chung, G.K MIMO- OFDM Wireless Communication with MATLAB,Clementi Loop, Singapore, pp 19-337. (2010)

[3] Foschini, G.J and Gans, M.J. On limits of wireless communication in a fading Environment when using multiple antenna, *Wireless personal communication 6(8)*:311-335. (1988)

[4] Laneman, J, Tse, D and Wornel. G. Cooperative diversity in wireless network: Efficient protocols and outage behavior *"IEEE transaction. on information* Theory" 50(12):3062-3068. (2004)

[5] Fan, Y, and Thompson, C.W. Wireless communication on the diversity multiplexing Trade off concurrent Decode and forward Relaying, *IEEE Wireless Communications and Networking Conference (WCNC")*, Las Vegas, USA, 6(7): 1774–1786. (2008)

[6] Rank, B and Wittned. A Spectral efficient protocols for half –Duplex fading Relay. *IEEE journal on selected areas in communication* 25(12):379-390. (2007*).*

[7] Mheidat, H and Uysal, M. Impact of receive diversity on the performance of Amplify and forward relay under access point service and power constraints, *IEEE communication letter*,10(27): 468-475. (2006).

[8] Yeoh, P.L, Maged, E and Collings, I.B Selection Relaying with Transmit Beaforming: A Comparison of Fixed and Variable Gain Relaying, *IEEE Transaction on Communication"*59(6): 1-6. (2011).

[9] Rappaport, T. S. Wireless Communication Principles and Practice, second edition, upper saddle river, New jersey. pp 1-653 (2002).
[10] Sharma, S Mobile and Wireless Communication, Danj Ganj, New Delhi p.127, (2012)
[11] Goldsmith, A Wireless Communications, Cambridge University Press, Stanford University.pp 9-363. (2004)
[12] Mohammed, H, Ahmmed and Salama, I Performance Analysis of Cooperative Diversity Using Equal Gain Combining Technique over Rayleigh Fading Channel, *IEEE Transaction onwireless communication*, 9 (4) :1-6 (2012).
[13] Nasaruddin, Mayliana and Roslidar Performance of Multi-relay Cooperative Communication Using Decode and Forward Relay, *International Journal of Scientific & Engineering Research* 18(7): 1-5. (2012).
[14] Jian, O, Min, L and Fie, Y "Performance Analysis of Cooperative Fixed Gain Relaying Over Asymmetric Fading Channel"*journal of Electronics and communication Engineering* 89(96):89-96. (2013)
[15] Akande, D.O, Ojo, F.K and Odebowale, O.A Performance of MPSK and MQAM Modulation on Cooperative Relaying Systems over Rayleigh Fading Environment, *International Journal of Scientific & Engineering Research* 6 (7): 1-5. (2015)
[16] George, K.K, Smith, P and Himal, A.S Performance Analysis of Dual- Hop Asymmetric Fading Channel, *IEEE transaction on wireless Communications* 8(6):1-6 (2009).
[17] Simeon M.K.and Alouini, M. S, "Digital Communications Over Fading Channels*",*2nd edition, John Wiley and Sons, Incorporation, Hoboken, New Jersey, (2005), PP 1 – 523.
[18] Proakis, J. G, "Digital Communications*",* McGraw-Hill companies, incorporation. International Edition, 2001.
[19] Adeyemo, Z. K. and Ojedokun Isaac A., "EGC Receiver using single Radio Frequency chain and single matched filter over combined Rayleigh and Rician Fading channels" ARPN Journal of Engineering and Applied Science, (2014). 9(7): 1819-6608.
[20] Adeyemo, Z. K. and Raji T. I, "Effects of Diversity combining in mobile Terrestrial Environment" Continental Journal of Engineering Sciences 5:27-37. (2010).