A Novel MAMR Approach for Optimal Performance Cooperative Network with Nakagami Fading Environment

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Abstract –Multipath fading, interference, and scarcity of power and bandwidth are the main limitations in any wireless communication system. The multipath fading problem can be solved by applying spatial transmit/receive diversity techniques. Dual hop cooperative relay network is the research priority among the researchers due to coming trend of mobile devices and increasing traffic of data over communication system. Due to this there is need to enhance the performance of the existing system, and in this respect here we are enhancing the performance of cooperative network in nakagami fading environment using multiple antennas and multiple relays(MAMR) in network which significantly gives better results as compared to existing schemes. The simulation results show the performance in terms of outage probability. From the results it is clear that the utilization of multiple antennas and use of multiple relays increases the performance of the system significantly.

Keywords: Multi Antenna Multi Relay, Dual-hop systems, Nakagami Fading, outage probability.

I. INTRODUCTION

Dual- Nowadays, the acceleration on wireless communication places demands on high data rate and high throughput requirements. In addition, wireless communication has become a part of our daily routine as in our homes, cars and computers. Cellular phones as an example of wireless systems, are important as they permit users to stay connected at any- place at any time with voice, multimedia, and high-speed Internet services. The common aspect of those services is that they require reliable link over different environments, and also require stable network in terms of spectral efficiency, system capacity, and trans- mission range. In order to fulfill the above goals, wireless systems' designers face many physical limitations such as signal fading occurring from multipath propagation, band- width limitation for each service provider, and transmitted power where wireless devices should offer long battery life and device size.

To improve spectral efficiency and utilize the available bandwidth in wireless systems, multiple access techniques are employed such that communication resources are shared among different users. The available communication resources can be shared among multiple users in many ways as in frequency division multiple access (FDMA), time division multiple access (TDMA), and code-division multiple-access (CDMA) where the signaling space is shared different dimensions (frequency, time, and code) respectively.

FDMA and TDMA are orthogonal multiplexing methods over frequency and time, respectively. In CDMA, the signal is modulated by a pseudo noise sequence and transmitted over the whole system bandwidth. Anti-multipath capabilities, soft capacity, soft hand off, and potential capacity increases over other multiple-access techniques are some of the characteristics of the direct sequence code division multiple access (DS-CDMA). Signifi- cant performance improvements are achieved from multi-user detection (MUD) techniques for DS-CDMA compared with the conventional receiver. The main advantage of the asynchronous CDMA over synchronous CDMA, TDMA and FDMA is its ability to use the spectrum more efficiently in mobile networks.

Diversity is one of the powerful communication techniques that mitigate the effect of fading resulting from the multipath propagation. Diversity techniques utilize the random nature of the radio propagation by using the independence of the faded version of the transmitted signal to enhance the system performance.

Since a repeater is able to counteract the signal attenuation, not only the received useful signal power at the destination is improved but also the coverage area is increased. These are two of the reasons why the use of repeaters, which are called relays, is foreseen for future wireless and mobile broadband radio.

Figure 1.1 shows an illustration of a communication between one BS and multiple nodes. The BS can directly communicate with node S1 since there is direct link be- tween them. Such communication is called direct, single-hop or point-to-point com- munication [11]. Due to the shadowed link caused by the building between BS and node S2 and due to the strongly attenuated link between the BS and node S3, the communication between the BS and both nodes S2 and S3 can be performed only via a relay station (RS). The BS sends the information first to the RS and the RS forwards the corresponding information to nodes S2 and S3. Since the communication needs to be performed within two hops, it is called two-hop communication.

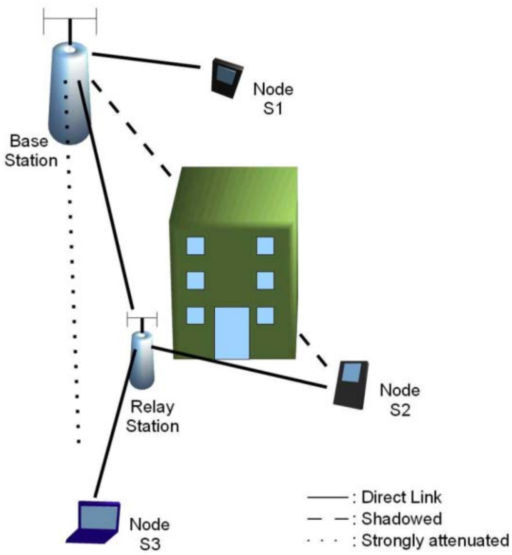

Figure 1.1 Illustration of the use of a relay station to support communication between a base station and multiple nodes.

Cooperative techniques are of a major importance in improving the performance of multiuser networks. Due to this importance, much works have been conducted to study and analyze the performance of cooperative networks. In the literature, minor contributions have been introduced in analyzing the performance of these diversity techniques in general fading channels such as the Nakagami-m model.

II. NAKAGAMI FADING THEORY

Rayleigh and Rician fading models have been widely used to simulate small scale fading environments over decades. States that Rayleigh fading falls short in describing long-distance fading effects with sufficient accuracy. M. Nakagami observed this fact and then formulated a parametric gamma function to describe his large-scale experiments on rapid fading in high frequency long-distance propagation. Although empirical, the formula is rather elegant and has proven useful.

Nakagami Fading occurs for multipath scattering with relatively larger time-delay spreads, with different clusters of reflected waves. Within any one cluster, the phases of individual reflected waves are random, but the time delays are approximately equal for all the waves. As a result the envelope of each cluster signal is Rayleigh Distributed. The average time delay is assumed to differ between the clusters. If the delay times are significantly exceed the bit period of digital link, the different clusters produce serious intersymbol interference.

The Nakagami Distribution described the magnitude of the received envelope by the distribution.

$$p(r) = \frac{2}{\Gamma(m)}\left(\frac{m}{\Omega_p}\right)^m r^{2m-1} \exp\left\{-\frac{mr^2}{\Omega_p}\right\} \; r \geq 0, m \geq \frac{1}{2}$$

$\Omega_p = E(r^2)$Is an instantaneous power.

$m = \frac{E(r^2)}{Var\,(r^2)}$ is a fading figure or shape factor

The following are the facts about Nakagami Fading.

- If the envelope is Nakagami Distributed, the corresponding power is Gamma distributed.
- The parameter ‘m’ is called fading figure or shape factor and denotes the severity of fading.
- In the special case m=1, Rayleigh fading is recovered, with an exponentially distributed instantaneous power.
- For m > 1, the fluctuations of the signal strength are reduced as compared to Rayleigh Fading.
- For m=0.5, it becomes one-sided Gaussian distribution.
- For $m = \infty$, the distribution becomes impulse. I.e. no fading.
- The sum of multiple independent and identically distributed Rayleigh-fading signals has Nakagami Distributed signal amplitude.
- The Rician and Nakagami model behave approximately equivalently near their mean value. While this may be true for main body of the probability density, it becomes highly inaccurate for tails. As the outage mainly occurs during the deep fades, these quality measures are mainly determined by the tail of the probability density function. (For the probability to receive less power).

III. PROPOSED METHODOLOGY

In this research work firstly initialization and simulation environment creation has done in Matlab. After parameter Initialization that considers a dual-hop relay and create Nakagami Fading model for dual hop MAMR system. Figure 3.1 shows the flow of proposed algorithm the steps of simulation are as follows.

Step: 1 Start Simulation with Matlab Simulation environment.

Step: 2 Environment variable innitialization.

Step: 3 Apply Nakagami Model on Dual Hop System for Multi Antenna & Multi Relay.

Step: 4 Calculate probability of output voltage for all SNR values (0-30dB).

Step: 5 Calculate results with different values of relays and Antennna.

Step: 6 End Simulations.

Dual-hop relaying transmission, as a means to improve the throughput and extend the coverage of the wireless communication system, has recently received enormous interests in the context of cooperative communications where an intermediate mobile device acts as a relay node and helps forward the signal received from the source node to the intended destination node. Apply Nakagami Model on dual hop system for multi antenna & multi relay. Finally calculate output probability for All SNR Values 0-30 dB. Compare those results with Different Values of Relays & Antennas.

Unlike the generation of Rayleigh fading signals, the generation of Nakagami fading signals is different. Typically Rayleigh signals can be generated from two low-pass Gaussian processes i.e. in-phase and quadrature components and their magnitude follows Rayleigh distribution.

It can model signals in severe, moderate, light, and no fading environment by adjusting its shape parameter, m. Actually sum of mutually exclusive Hoyt and Rician models is the Nakagami distribution.

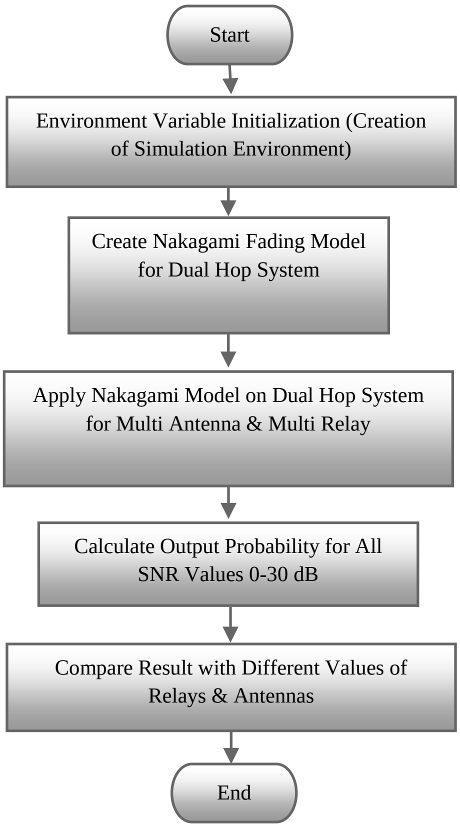

Figure 3.1. Shows Flow Graph of Proposed Methodology.

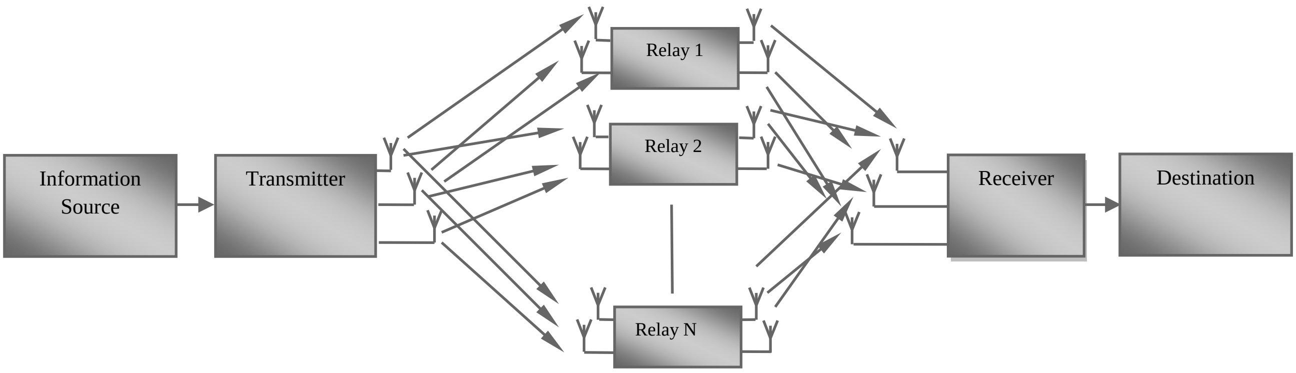

Figure 3.2 Block Diagram of Proposed Methodology

Dual-hop relaying transmission, as a means to improve the throughput and extend the coverage of the wireless communication system, has recently received enormous interests in the context of cooperative communications where an intermediate mobile device acts as a relay node and helps forward the signal received from the source node to the intended destination node. Apply Nakagami Model on dual hop system for multi antenna & multi relay. Finally calculate output probability for All SNR Values 0-30 dB. Compare those results with Different Values of Relays & Antennas.

It can model signals in severe, moderate, light, and no fading environment by adjusting its shape parameter, m. actually sum of mutually exclusive Hoyt and Rician models is the Nakagami-m distribution.

Figure 3.2 shows the block representation of a typical MAMR relay network. As shown in figure there are multiple antennas at transmitter and receiver end and between transmitter and receiver there are multiple Relay network having multiple antennas.

Hence the transmission occurs in two hops. In first hop the transmitter transmit the desired signal to relays, in second hope relay transmit received signal to destination.

IV. SIMULATION RESULTS

The multi antenna multi relay dual hop cooperative relay system with nakagami fading has been implemented on MATLAB. The simulation result shows the performance in terms of outage probability. There are different terms of performance measurements. BER is the performance measure of the receiver and outage probability is a measurement of the channel, the channel capacity or throughput of information that can be transmitted via the communication channel affected by noise or signal fading letting to have smaller values of SNR. For a channel with the similar outage probability we could have two different BERs for two receivers.

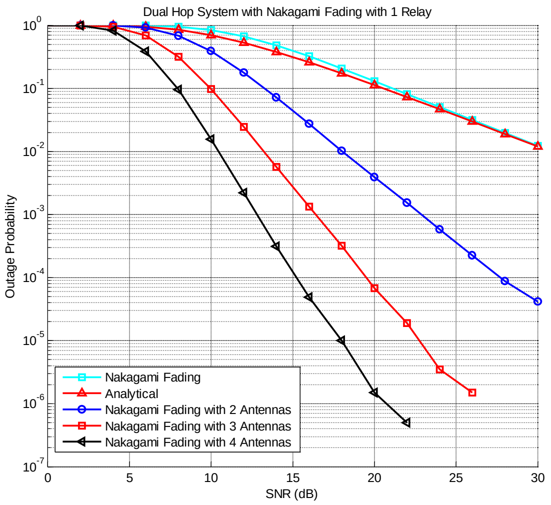

Fig. 4.1 Outage Probability of Dual Hop Cooperative Relay system with multiple antennas and *R=1*

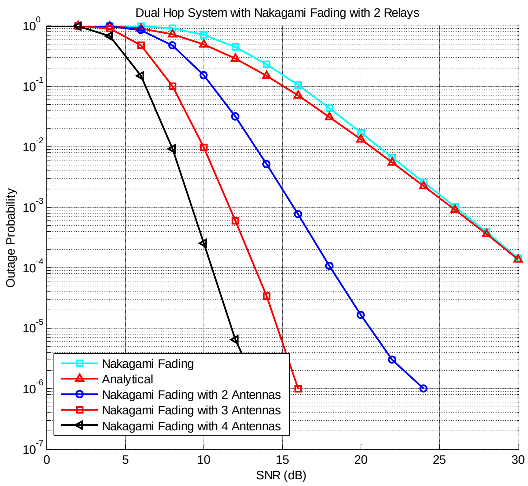

Fig. 4.2 Outage Probability of Dual Hop Cooperative Relay system with multiple antennas and *R=2*

The complete simulation is performed using different system configurations as shown in the results below. Fig. 4.1 shows the outage probability of the dual hop cooperative relay system with single relay and multiple antennas (here we have taken one, two, three and four antennas). The system is simulated under Nakagami-Fading environment.

From the comparison shown in the result shown in Fig. 4.1 we can say that the outage probability will be decreases with the increase of number of antennas keeping the relay constant i.e. one.

Fig. 4.2 shows the outage probability of the dual hop cooperative relay system with two relays and multiple antennas (here we have taken one, two, three and four antennas). The system is simulated under Nakagami-Fading environment.

From the comparison shown in the result shown in Fig. 4.2 we can say that the outage probability will be decreases with the increase of number of antennas keeping the relay constant i.e. two. The comparison from the previous results it is also clear that the additional relay increases the performance of the system, which significantly reduces the outage probability of the cooperative relay system.

Fig. 4.3 shows the outage probability of the dual hop cooperative relay system with three relays and multiple antennas (here we have taken one, two, three and four antennas). The system is simulated under Nakagami-Fading environment.

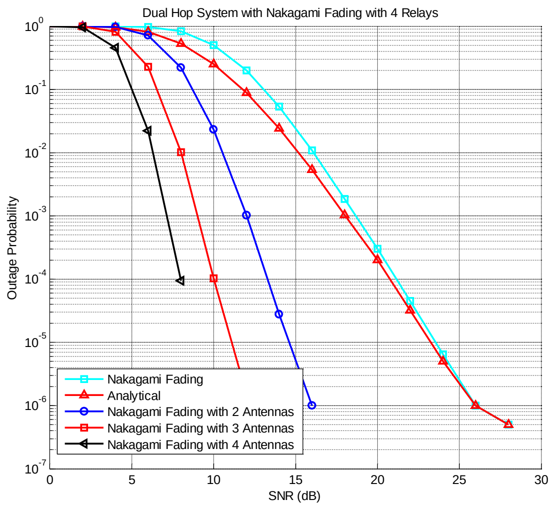

Fig. 4.3 Outage Probability of Dual Hop Cooperative Relay system with multiple antennas and *R=4*

From the comparison shown in the result shown in Fig. 4.3 we can say that the outage probability will be decreases with the increase of number of antennas keeping the relay constant i.e. three.

From the comparison shown in the result shown in Fig. 4.1 and Fig. 4.2 we can say that the outage probability will be decreases with the increase of number of antennas keeping the relay constant i.e. two. The comparison from the previous results it is also clear that the additional relay increases the performance of the system, which significantly reduces the outage probability of the cooperative relay system.

V. CONCLUSION AND FUTURE SCOPES

The proposed multi relay multi antenna dual hop cooperative relay system is simulated and the results shown in the previous section. The performance of multiuser AF relay networks has been studied in this work where the approximation for the outage probability over Rayleigh fading channels has derived. All the simulation outcomes show that the proposed methodology which has the more than one antenna and multiple relays enhances the performance of existing system. The outcome measured in terms of outage probability which should be as low as possible to make system more robust and efficient.

Performance analysis of MAMR cooperative networks over Nakagami fading channels is presented where a complete analytical method is introduced to obtain closed-form expressions for outage probability using DF and AF over Nakagami fading channels.

Though the proposed work has limited to evaluate outage probability in future the proposed can be extended to calculate BER and also consider the reliability of the (user-relay) and (relay-base station) links could be included in future works.

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