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Packet Combining Using Soft Bit Maximal Ratio Combining Technique in Wireless Cooperative Relay Network

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ABSTRACT

Relays can be classified into digital and analog relays. Analog relays amplify and-forward (AF) the received signal without any decoding while digital relays fully decode and forward (DF) a regenerated version of the received signal. Here we are using digital relays as it is the focus of most of the next generation wireless networks standards such as IEEE 802.16j/m [2] and LTE-Advanced. The single-user single-relay network depicted in Fig. 1. In the first time slot, the BS transmits the signal to the RS and the signal is overheard by the UT, because of the broadcast nature of the electromagnetic waves. The RS fully decodes the signal and forwards it to the UT in the next time slot. In conventional relaying, the UT decodes the signal from the RS only. In cooperative relaying, the UT properly performs diversity combining of the signals it receives from the BS and RS. Since these signals experience uncorrelated fading, combining achieves diversity and thus reduces the effect of fading significantly.

Key words: Wimax, SBMRC, cooperative relay network, MLD

INTRODUCTION

The major upcoming milestone in wireless cellular networks is the development and standardization of the fourth generation (4G) cellular networks. To achieve the high data rate and error free reception in 4G technology we are going to introduce the cooperative relay network in which the packet combining take place with the help of soft bit maximal ratio combining(SBMRC) technique, which is used to increase the throughput of network as well as to reduce the packet delivery delay. In digital cooperative relay network the signal from source to destination are combined at the destination to achieve the spatial diversity. The signal not necessary belongs from same modulation technique due to varying channel condition of various links. This technique will be implementing for wireless network up to large area of 10 km. The adaptive modulation and coding will use in the different channel in which each channel has the different modulation scheme such as 16 bit, 32 bit, 64 bit QAM and then all spatial diversity signal will combine at the receiver by SBMRC technique in which the signal from MRC decoded one by one until packet is decoded correctly with the help of cyclic redundancy code. This SBMRC technique will help to avoid the computation of the conditional PDF's in the detection process.

Co-operative Relay Network

In cooperative relay network the cooperative diversity is used. Cooperative diversity can be performed based on a few different relaying strategies such as amplify-and-forward, decode-and-forward, and compress-and-forward strategies.

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We introduce the schemes to decode the signal at the destination node which is the adaptive scheme where the decoding takes place at the relay stations (RS) irrespective of channel variation. Relays can be further classified into fixed and nomadic relays. As the name implies, fixed relays are deployed by the service provider in strategic locations while nomadic relays are mobile relays that can be provided by the service provider or can be idle UTs that help other UTs. Here we are we address both fixed and nomadic relays. Since fixed relays are installed at strategic locations, Line-of-Sight transmission between the BS and the RS can be achieved in most cases. Consequently, from the physical layer prospective, the difference between fixed and nomadic RSs is that, in the former the link from BS to RS is reliable and can be assumed error free, for all practical purposes. However, the error free assumption does not hold in the case of nomadic RSs. In nomadic relays, the errors made at the RS propagate to the destination.

System Model

We are considering here the multipath network with L transmitting node and a user terminal UT. The relay stations (RS) are used to decode and amplify the signal received from base station (BS) and forward it to the UT in. This is the process of downlink which is shown in Fig1.Also we are considering the uplink process in which there is L transmitting nodes and a BS. This layout is shown in Fig 2. Here RS will decode and amplify the signal received from UT and forward it to BS station.

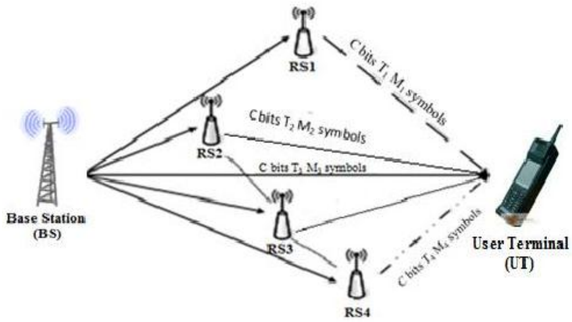

Fig. 1 System model for Downlink

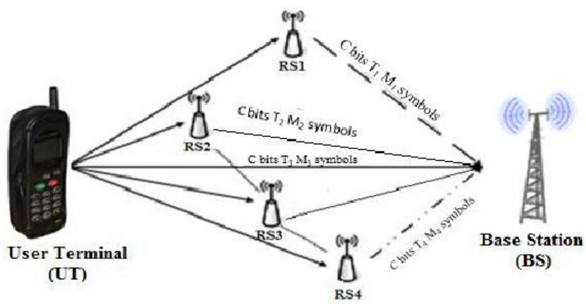

Fig. 2 System model for Uplink

The transmitting nodes transmit on L-orthogonal channels, i.e., they do not interfere with each other. For simplicity, we consider TDMA to insure orthogonal transmission from all the nodes. The transmitting node i, (BS or RS_i) where i 0, 1, ..., L-1 , uses square M_i Quadrature Amplitude Modulation (M_i-QAM) with Gray coding. Each M_i -QAM symbol carries K_i bits, where $K_i=\log_2 M_i$ and M_i is the i^{th} modulation level. Without loss of generality, the M_i-QAM constellation has an average energy per bit equal to unity.

In wireless network data is converted into frame and frame transmission takes place .The frame is divided into L sub-frames, i.e., one sub-frame for each transmitting node. All sub-frames contain the same sequence of bit denoted by $\{S_0, S_1 ...Sc_{-1}\}$. The i^{th} frame consists of T_i M_i-QAM symbol. Each denoted by $S^{Mi}_{i,j}$. Where j € {0, 1 ...Ti-1}.

In the zeroth sub-frame, BS broadcasts T_0 M_0-QAM symbols to all RSs and the UT. Since the RSs can be installed at strategic locations, the BS to RSs links can be made very reliable as it is possible in most of the cases to have line-of sight transmission in these links. Thus, the RSs can decode the signals with negligible errors. In the i^{th} sub-frame, RSi forwards T_i symbols to UT using M_i-QAM modulation. Similarly in uplink process the i^{th} sub-frame RSi forwards T_i symbols to BS using M_i-QAM modulation the frame structure is depicted in Fig 3.

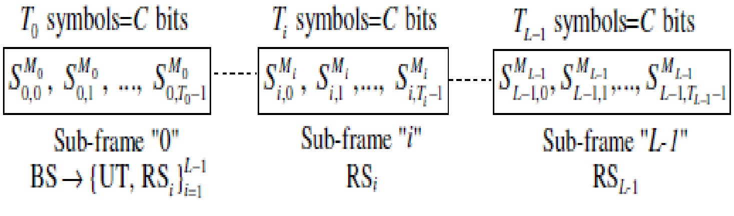

Fig. 3 Frame structure

The channel coefficient between the transmitting node i and UT is denoted by αi and it captures both path-loss distant dependant attenuation and small scale fading due to multipath propagation. The multipath fading is assumed to be slow, i.e., the channel does not change for the duration of a whole sub-frame. It is assumed that αi's are known at the receiver and are modelled as independent CN (0, $\sigma^2 i$), with $\sigma^2{}_i$ = {|$\alpha^2 i$|}. If full channel state information (CSI) is available at BS, deciding whether to communicate through relays or directly, and optimizing the modulation levels for all the transmitting nodes, can improve the end-to-end throughput drastically. Such optimization is studied extensively (for instance, [4], [5]) and will not be repeated here. We emphasize that relays are used opportunistically, i.e., whenever the end-to-end throughput using the relays is larger than that of the direct link. In this work, we focus only on the cases when the relays are used. The instantaneous signal-to-noise ratio (SNR) per bit of the link from node to UT is γ_i = $|\alpha i|^2$SNR, and the average SNR is denoted as $\bar{\gamma}_i = \sigma^2 i$ SNR.
Where SNR is a reference SNR equal to SNR = E_b/N_0.
After receiving all the sub-frames, UT can utilize the signals received from L independent branches, and achieve spatial diversity.
For designing our system model we have considered an area of 10 KM which is bout an aentire city area and in this area we have designed the mobile adhoc network scenario that contains a fixed base station (BS) and three relay stations, also the moving mobile user are communicated with each other via base station and relays station. Base station is situated at a strategic location from which it will provide full network coverage to entire city based area. The function of the relay is to amplify and decode the data received from BS or mobile user. The mobility of the mobile user are also decides as per the actual network behaviour of a city where they are moving randomly with different speed allocated to them.
We have designed our network for two different routing protocols that are AODV and DSDV, the performance metrics of this protocol are compares with the scenario of simulation. The another aim of this research is to implement the SBMRC technique for the same network by which the result will further improved and we get maximum optimum possible results. The work for the SBMRC is going on which is to be published in next issue. Following are the parameter considered for the simulation of the network.

Table -1 Simulation Parameters

Sr. No.	Network Parameter	Value
1	Channel Type	Wireless Channel
2	Propagation Model	Two ray ground propagation (Full duplex)
3	MAC Type	802.16 (WIMAX)
4	Antenna Type	Omni directional
5	Routing Protocol	AODV/DSDV
6	No. of Fixed Nodes	04
7	No. of Mobile user	15
8	Simulation Area	1000m x 1000 m
9	Speed of Mobile user	10ms/s, 20m/s,40m/s, 60 m/s

Soft Bit Maximal Ratio Combiner (SBMRC)

In the MLD, the complexity arises from the fact that different modulation schemes carry different number of bits per symbol. As a result, bit-by-bit (or symbol-by-symbol) decoding is not possible. In order to avoid such high complexity, the received Mi-QAM symbol ri,j is mapped into Ki soft bits. Then, decoding can be performed on the soft-bits, which results in bit-by-bit detection, rather than detecting a sequence of bits jointly. To extract soft-bits from a soft-symbol, the LLR can be used. The LLR is a well known technique and it is being used in many channel coding schemes. For the Gray coded Mi-QAM schemes described by the LLR can be well approximated by the following recursive expression. The SBMRC adds the soft-bits in a way similar to MRC, hence the name SBMRC. The block diagram of SBMRC is shown in Figure 4.

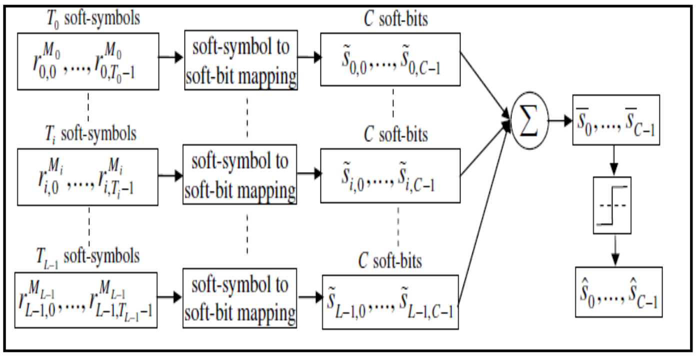

Fig. 4 SBMRC block diagram

RESULTS AND DISCUSSION

In this research we have considered wimax network for mobile adhoc network in which three relay stations connected to a single base station and various wireless nodes are attached via relay station to base station. The software we have used here is NS2.31 on which we have installed wimax module and simulated the network for city based mobile network by considering the city area of 10 KM.

Following image shows that the base station (BS) situated at the centre of city and three relay (RS) stations are covering to the base station located at different parts of the city. The mobility also considered as like city based mobile network behaviour.

Here we have simulated scenario where some of the mobile users (nodes) are moving towards the base station, some users moving away from the base station and some are at fixed position. It means it is like virtual network of the mobile users operated in the city environment. Following image shows the NS2 simulated network for initial time of the simulation.

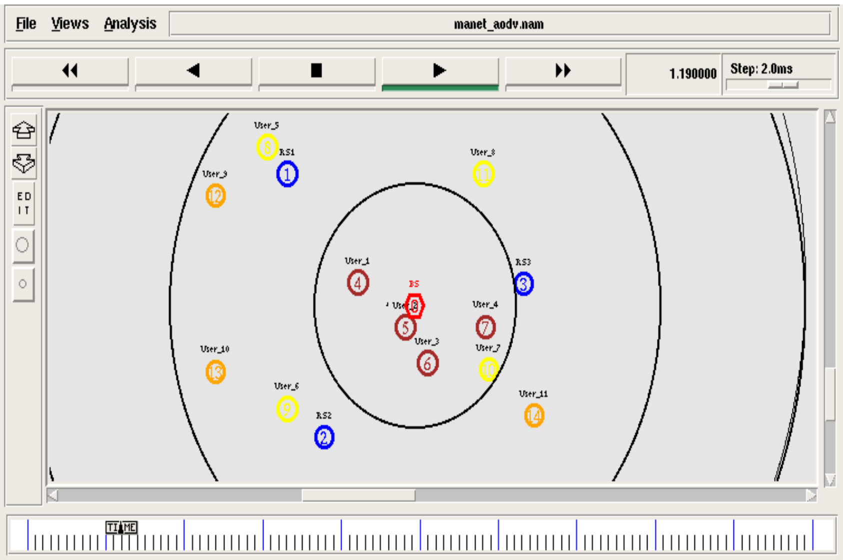

Image 1: Simulation of network at time 1.19 sec

In above image the network just started and nodes are moving accordingly. The simulation time is 1.19 sec and the step of time increasing at rate of 2ms. The base station (BS) shown in red color, relay station (RS) are in blue colors and mobile users (nodes) as in yellow, orange and brown colors. The circular rings shown the active node and their respective coverage area

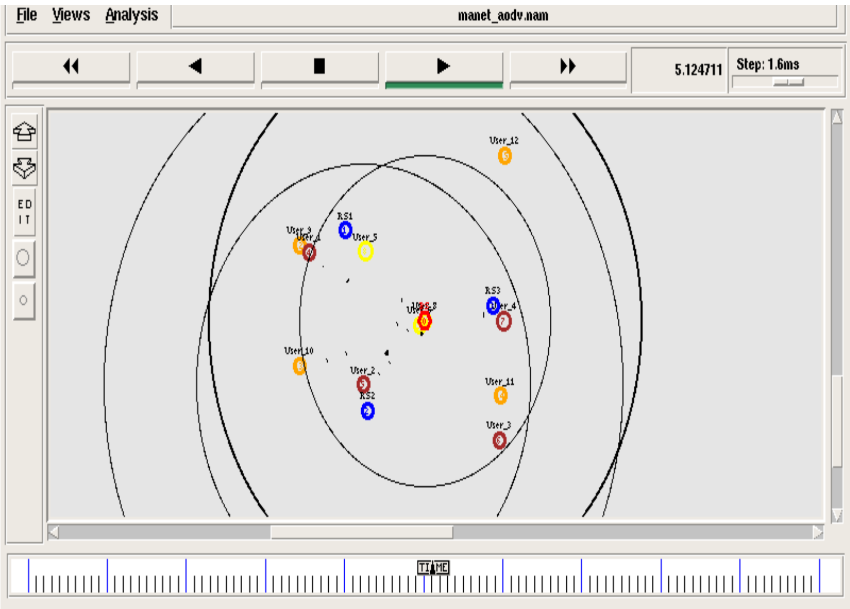

Image 2: Simulation of network at time 5.14 sec

Above image show the simulation time of the network at middle of simulation time as 5.12 sec with the step rate of 1.8ms. the dotted black colors indicates the communication of mobile users with the relay as well as base station. The position of the nodes as per previous image is different as the simulation time change.

Table 2: Comparative analysis of AODV and DSDV protocols without SBMRC

Sr. No.	Parameter	Result for AODV protocol	Result for DSDV protocol
1	Start time	0.000 Sec	0.000 Sec
2	Stop Time	10.000 Sec	10.000 Sec
3	Throughput of network	477.93 Kbps	423.34 Kbps
4	No. of packet sent	1318	1318
5	No. of packet received	1130	1016 %
6	Packet Delivery Ratio	85.73 %	77.08 %
7	Packet Loss Ratio	14.26	22.91

CONCLUSION

From the result and the protocol used in the communication of network it is concluded that the result of the AODV protocol are better than DSDV because of on demand nature of AODV. In DSDV protocol the routing table updation and node connectivity continuously monitoring is done so the power losses are more which decreases the result of throughput and packet delivery ratio. Yet SBMRC technique is not applied in this work so the result of network further increases and optimum performance of network can be achieved through SBMRC.

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