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DEL-CMAC Protocol together with Cross-Layer Cooperative Diversity Approach to Improve the Network Lifetime of MANET

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Abstract— A wireless communication network is rich in interference and noise which makes the communication in the network unreliable. There has been many active research on cooperative communication which helps in improving the reliability of wireless network. To enhance the spectral and power efficiency, lifetime of the network, and reduce outage probability, cooperative communications with relaying nodes are very effective. Relaying induce complicated medium access interactions, to handle these interactions and to capitalize the benefits of cooperation an efficient Cooperative MAC protocol is required . This paper proposes, Distributed Energy-adaptive Location-based CMAC protocol, namely DEL-CMAC along with effective cross layer cooperative diversity approach for MANET. Cross layer handles the interaction between higher layer and cooperative diversity is used for diversity gain in the network where relay nodes are used. The use of cooperative diversity in the network leads to increase in reliability in the network. The design objective of proposed work is to improve the network lifetime of MANET by reducing the power consumption and improving the throughput.

Index Terms— Cooperative Communication, Cooperative Diversity, DEL-CMAC, Energy-Efficiency, Network Lifetime, Power Consumption, Relaying.

1 INTRODUCTION

A Mobile Ad-hoc Network (MANET) has mobile nodes that are connected by wireless links which are self-configured network. By participating in MANETs, when they are not in the range of Wi-Fi access points or cellular base stations, or communicate with each other when no networking infrastructure is available these terminals may reach the Internet. One primary issue with continuous participation in MANETs is the network lifetime, because the aforementioned wireless terminals are battery powered, and energy is a scarce resource [2].

In wireless networks, due to communication environment the fading occurs in the signal and also the surrounding nodes in the network causes interference, fading and interference are the two major obstacles for obtaining best performance while delivering signals. These critical problems can be solved by including cooperation among the nodes. Cooperation is performed by selecting the intermediate node for the given source destination pair for delivering the message accurately, which is supported by conventional routing layer solutions. However, if the nodes present in the network is not coordinated to cooperate at lower levels , it is very difficult to obtain the maximized performance of the network. This is because MAC and Physical layer protocols often determine the capacity of network.

Cooperative communication is considered to be a good technique for energy consumption in MANETs, but is not considered to be efficient in direct transmission. CC can provide gains in terms of the required transmitting power due to the spatial diversity achieved via user cooperation. However, if we take into account the extra processing and receiving energy consumption required for cooperation, CC is not always energy efficient compared to direct transmission. There is a tradeoff between the gains in transmitting power and the losses in extra energy consumption overhead. [1]

A CMAC protocols named Coop-MAC was designed to perform the multi-rate capability and aimed at mitigating the throughput bottleneck caused by the low data rate nodes, so that the throughput can be increased. A reactive network coding aware CMAC protocol has been proposed in which, which simultaneously does the work of delivering its own data and forward the data through the relay node for the source node [8]. A distributed CMAC protocol has been proposed to improve the lifetime of wireless sensor networks, but it is based on the assumption that every node can connect to the base station within one hop, which is impractical for most applications. The existing CMAC protocols mainly focus on the throughput enhancement while failing to investigate the energy efficiency or network lifetime. While the works on energy efficiency and network lifetime generally fixate on physical layer[10] or network layer[9]. Our work focuses is on combining both the layer and its properties to form a cross layer approach. Cross layer design integrates the properties of higher layer to so that both physical layer and MAC layer properties can be used together.

Using cross layer with cooperative diversity is very efficient way of increasing the reliability of the network. Cooperative diversity is a technique which works when relay nodes are considered. two independent signals are transmitted by the source node to the relay node and the destination node, the destination node receives signal from both the node, relay as well as source. When source node transmits the signal directly to the destination node then interference and noise in the signal is more therefore relay nodes are used to transmit the signal, with the help of these nodes the quality of signal received at the destination is improved. The use of cooperative diversity is to mitigate the impact of fading as well.

In this paper section 2 represents the related work on the improving the network lifetime of MANET. Section 3 consists of system and energy models. Section 4 explains the working of proposed protocol. Section 5 explains the details of supplements that are added to proposed protocol. Section 6 displays

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simulation results of the proposed technique. Section 7 is the conclusion thus followed by references.

2 Related Work

The network lifetime of MANET has been increased in several ways using many protocols as CMAC, DEL-CMAC and also strategies like energy efficient power allocation strategy, optimal grouping strategy, each method has their pros and cons.

In terms of energy consumption cooperative communication is considered to be a good technique, but whenever direct transmission occurs it gives poor performance in terms of energy. With the help of cooperation among the nodes spatial diversity can be achieved using cooperative communication which provides gains regarding the transmitting power. However, whenever extra processing and receiving energy is considered, it is not necessary that cooperative transmission will always be energy efficient when compared to direct transmission. There is a tradeoff between the gains in transmitting power and the losses in extra energy consumption overhead.

A CMAC protocols named Coop-MAC is introduced to deal with the decreasing throughput, and increase it. A reactive network coding aware CMAC protocol has been proposed in which, which simultaneously does the work of delivering its own data and forward the data through the relay node for the source node. A distributed CMAC protocol has been proposed to improve the lifetime of wireless sensor networks, but it is based on the assumption that every node can connect to the base station within one hop, which is impractical for most applications. The existing CMAC protocols mainly focus on the throughput enhancement while failing to investigate the energy efficiency or network lifetime. While the works on energy efficiency and network lifetime can be fixed on physical layer or network layer.

To overcome CMAC a DEL-CMAC i.e Location Aware CMAC protocol has been introduced to increase the network lifetime of MANET. The main aim was to increase the network lifetime and energy efficiency. So two new control frames were added in the MAC layer named ETH and II i.e Eager-to-help and Interference-Indicator. But these control frames increased the overhead of MAC as it is added to the MAC header. The work has not been done for increasing the network lifetime in large network with high mobility. As a result of this protocol the throughput is minimized but the delay increases.

For increasing the power and energy of the system an energy efficient Multi-relay Cooperative Communication is used. In this an energy efficient relay selection strategy is given and also a power allocation strategy. First of all a transmission mode is selected based on the energy efficiency of the transmission link and the energy efficiency of the system is analyzed. But it uses all the available power which is not an optimal solution as well as the efficiency is achieved at the price of system performance.

For delay, the reliability constraints in wireless network are considered. A Lyapunov optimization is used to make optimal use of network resources that are available. Here a mobile adhoc network with limited delay and cooperative communication is considered. The concept of known channel and unknown statistics and vice versa model is used. In this it is impossible to achieve 95% reliability with direct transmission alone.

Considering throughput and delay constraints, a cross layer scheme is introduced in which a optimal grouping strategy is used for efficient helper node selection and a greedy algorithm for MAC protocol to increase the network throughput. Analysis is done for both cooperative and direct transmission. Here a cross layer cooperative MAC protocol is used that is able to distinguish beneficial cooperation from unnecessary cooperation. But high diversity gain is not achieved with more neighbor nodes.

Considering the above comparative analysis a new system is proposed which uses DEL-CMAC protocol using energy efficient relay selection and power allocation strategy along with the cross layer optimization using cooperative diversity protocol in a larger and highly mobile network which helps in power reduction , improving the throughput and enhancing the network lifetime of MANET.

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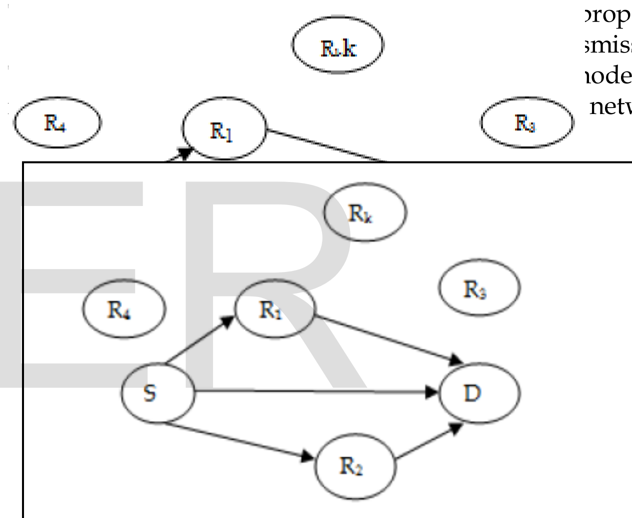

Fig.1. System Architecture

When the packet transmission starts, it starts from the source node S towards the destination node. The other nodes in the network become the relay nodes. The direct transmission takes place from source to destination without any relay but due to change in topology, the distance between the source and the destination increases which consumes more power due to more noise in the network. In this condition cooperative transmission occurs which uses relay nodes present between the source and the destination . The transmission either occurs in one hop or in multi hop with multiple relays. For cooperative transmission relay selection is very important aspect. Among multiple relays the best relay is selected based on the residual energy and backoff timer. The use of relay nodes is appropriate only when direct transmission fails.

In the system, wireless network topology is considered with highly mobile network. Further, a single- hop and multi-hop scenario are considered. The main focus is on cooperative transmission for multi-hop network with multiple relays. A multi-hop network comprises of one or more single hop network within it. A single-hop network consist of a source, a destination and a relay node where as a multi-hop network consists of a source, a destination and multiple relays. As relays are considered so power allocation and relay selection both are major task, which is not possible only with the physical layer properties, therefore cross layer approach is proposed where relay selection is in MAC layer and power allocation in physical layer. The relay selection and power allocation are combined to form a scheme called RTS-CTS signaling scheme which provides full diversity as well as prolongs the lifetime of network. Cross-layer is the approach which integrates the functionalities of higher layer. the strategy here is , the destination decodes the signal received either from the source or from relays instead of combining together.

A Decode-and-Forward (DF) scheme is used as the relaying scheme along with the concept of cooperative diversity. If the number of relays are large between source and destination then cooperative diversity provides improved reliability as well as power consumption is reduced. If larger network is considered then there occurs lot of interference, cross layer optimization with cooperative diversity is used to enhance the network lifetime of MANET by reducing the power consumption, conserving energy as well as minimizing the delay degradation.

The channel model used here is very common in many cooperative networks, where the channels are quasi-static Rayleigh Fading channel and the noise that is assumed is Additional White Gaussian Noise (AWGN). This means that the coefficients of the channels may change from one frame to another but it remains constant during one complete frame. All the channel coefficients are not at all dependent on the complex Gaussian random variables having mean as zero and unit variance. The noise term is given as $N_{0.}$ The SNR value is considered to find the percentage of noise in the environment and when the data packets are considered the packets are send in digital form because Decode and forward scheme is used so bit-error -rate is considered with each packet.

Including all the above features a DEL-CMAC protocol is proposed along with cross layer optimization scheme using cooperative diversity which makes the network more reliable and helps in improving the network lifetime of MANET.

4 DEL-CMAC

In this paper, a Distributed Energy adaptive Location-based Cooperative MAC protocols for MANETs. DEL-CMAC protocol has been based on the IEEE 802.11 Distributed Coordination Functions (DCF).In this proposed work the DEL-CMAC comprises the following such as a relay that is involved in a handshaking process, optimal power allocation scheme, a distributed effectiveness-based best relay selection strategy, and an innovative Network Allocation Vector (NAV) setting. The contributions of the proposed work have been summarized as follows.

The proposed DEL-CMAC protocol mainly focuses an increasing the network lifetime it considering to overheads and interference due to cooperation and energy consumption.

- In a distributed energy-aware location-based best relay selection strategy is proposed in MANETs for comparing with the existing schemes based on channel condition.
- For a desired outage probability requirement, a cross layer optimal transmitting power allocation scheme is designed which conserves the energy and an effective cross layer optimization approach with cooperative diversity for routing is maintained to increase the throughput level.
- For gaining throughput and increasing the network lifetime an effective cross layer optimization scheme along with cooperative diversity is used

To deal with the presence of relay terminals and dynamic transmitting power an innovative NAV setting has been provided to avoid the collisions and enhance the spatial reuse.

4.1 Models and Preliminaries

In this section, the employed system and energy models and the background knowledge about DCF are presented.

4.1.1 Models

There are two types of relay terminals are considered in this network such as routing relay terminals and cooperative relay terminals. DEL-CMAC initiates the cooperation in a hop-by-hop manner by selecting the cooperative relay terminals. In this paper, the source and destination nodes are referred to as the nodes at MAC layer, and the relay terminals indicates the cooperative relay terminals.

4.1.2 DCF

The IEEE 802.11 DCF (Distributed Coordination Function) basic operations are similar to the proposed DEL-CMAC.

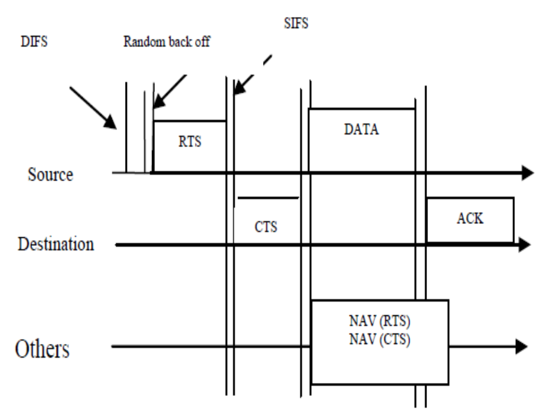

Fig.2. 802.11 DCF Block Diagram

In DCF, after a transmitting terminal senses an idle channel for duration of Distributed Inter Frame Space (DIFS), it backs off for a time period that is chosen from 0 to its Contention Window (CW). After the back off timer expires, the well-known

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RTS-CTS-DATA-ACK procedure is carried out as shown in Fig. 1.Any terminal which is taking off either the RTS or the CTS extracts the information contained in the MAC frame header, and sets its NAV setting to a time period that the channel is busy.

4.2 The Proposed DEL-CMAC Protocol

To deal with the relaying and dynamic transmitting power, besides the conventional control frames RTS, CTS and ACK, additional control frames are required. DEL-CMAC protocols adds two new control frames to make the cooperation easy for transmission, i.e., Eager-To-Help (ETH) and Interference- Indicator (II). The Eager-To-Help frame is used for selecting the best relay in a distributed manner considering the power consumption factors, which is sent by the winning relay to inform the source, destination and lost relays. In this paper, the best relay is defined as the relay that has the maximum residual energy and requires the minimum transmitting power among the capable relay candidates. In order to enhance the spatial reuse an Interference indicator frame is utilized which reconfirms that the interference range of allocated transmitting power is only at the winning relay. Among all the frames RTS, CTS, ETH and ACK are transmitted by fixed power and the transmitting powers for the Interference Indicator frame and data packet are dynamically allocated.

4.2.1 Protocol Description

The frame exchanging process of DEL-CMAC is shown in Fig. 4.2.1. The IEEE 802.11 DCF protocol, the RTS/ CTS handshake is used to reserve the channel at first. In DEL-CMAC, upon receiving the RTS frame, the destination computes the required transmitting power for the direct transmission. Unlike DCF, in the proposed protocol, the RTS packet carries the residual energy of the source and relay request message with corresponding relay address for supporting cooperative communication. After receiving the RTS, the destination sends CTS back after the period of Short Inter Frame Space (SIFS). All the nodes hearing CTS will update their table about the residual energy of the destination which is carried by CTS packet. If the source does not receive CTS within T_{rts}+T_{cts}+SIFS, a retransmission process will be initiated. Otherwise, after receiving CTS message from destination, the source waits for willing to Help (WTH) message from relay. All the nodes overhearing both RTS and CTS can act as relay. If a node accepts relay request, it sends WTH message to source. Source selects one potential node as relay. Then, the source sends data packet to relay using first hop data rate and relay forwards it to the destination with second hop data rate. If the destination can decode the combined signals correctly, it sends back an ACK. Otherwise, it just lets the source timeout and retransmits. If the source fails to receive WTH packet, it performs RTS-CTS procedure again for relay request from node next lowest transmission decision factor. Comparing with IEEE 802.11 DCF, the proposed scheme needs extra fields for RTS and CTS packet to carry relay request and residual energy. The RTS, CTS and WTH packets for proposed scheme are given in Figure 3

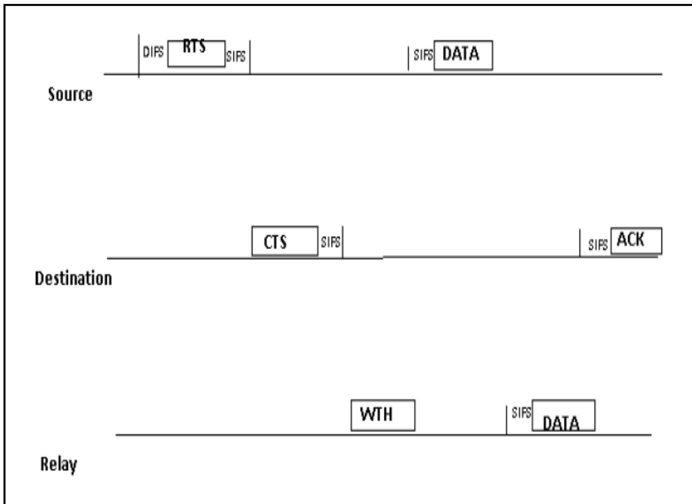

Fig.3. Frame Exchanging Process

There are two cases based on which the destination computes the required transmitting power to decide the type of transmission.

. • *Case (i)*: $PsD \leq \Delta p$. The destination sends a CTS frame with the flag field equal to 0, which implies that the direct transmission is required. Thus, when the transmitting power for the direct transmission is sufficiently low, DEL-CMAC is works in the same way as DCF protocol.

• *Case (ii)*: $PsD > \Delta p$. FLAG P in the CTS frame is set to 1, which implies that the cooperative transmission is required.. All the terminals having overhead RTS and CTS, and not interfere with other ongoing transmissions are considered as the relay candidates.

4.2.2 Operation at the Source

i) When a source wants to initiate the data transmission with payload length *L* bytes, it first senses the channel, whether it is idle or not. If the channel is found idle, the source selects a random back off timer between 0 and CW. When the back off counter reaches zero, the source sends out a RTS for reserving the channel.

ii) If the source does not receive CTS within $T_{RTS} + T_{CTS} + SIFS$, a retransmission process will be performed. Otherwise, in the case that FLAG _P of CTS is set to 0 and the DEL -CMAC works as DCF protocol.

iii) If both CTS and ETH are received, the source initiates a cooperative transmission using the optimal transmitting power.

iv)The source handles the next packet for transmission if proper acknowledgement is not received.

4.2.2 Operation at the Destination

i) Upon receiving the RTS, the destination sends CTS back after SIFS which contains the location information of the destination, the FLAG_P, and the transmitting power for the direct transmission PsD which can be used for the possible relay contention.

ii) In the case when FLAG_P is 1, if the destination has not

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heard any ETH within TmaxBackoff +TCTS +TETH+SIFS, it assumes that the direct transmission will be performed and waits for the data packet from the source or it sends back an ACK. Otherwise, it just lets the source timeout and retransmit.

4.2.2 Operation at the Relay

i) Any terminal that receives both RTS and CTS with FLAG_ P equals 1 and does not interfere with other transmissions in its range can be regarded as a relay candidate. Upon receiving the CTS, each relay candidate checks whether it is able to reduce the total energy consumption by the following equation,

(2PsD-PsC-PrC-2P')×(L+Lh)/2R-(PrC+P')×TII-(P+3P')×TETH>0

PsC and PrC refers to the transmitting power in the cooperative transmission mode for source and relay, PsD and
P refers to the transmitting power in the direct transmission mode for source and the fixed transmitting power respectively. The Term *(*2PsD-PsC-PrC-*2P')*×(L+Lh_*)/2R* denotes the energy consumption in transmitting the data by CC, the terms of (PrC+*P*'*)*×T11-(P+3P')×TETH additional energy consumption on control overhead.

By the given equation the relay checks whether CC can reduce the total energy consumption both on transmitting and receiving, compared to direct transmission.
ii) Intuitively, when the back off at a better relay expires earlier the best relay will be sending out an ETH first. The lost relays give up contention when sensing the ETH. The ETH contains the optimal transmitting power for the source.
iii) After SIFS, the winning relay will broadcast the II message using power. This II message is used to reconfirms the interference range of the relay with the objectives to enhance the spatial reuse. Then, the winning relay will wait for the data packet from the source to arrive.

5 Details and Supplements:

5.1 Utility Based Best Relay Selection

In this the best relay selection efficiently affects the performance of the CMAC protocol significantly. The existing relay selection schemes that incorporated into the CMAC protocols, depend on the channel condition, which is based on the assumption that the channel condition is invariant during one transmit session. For MANETS that deployed in heavily built-up urban environments or heavy traffic environments, this assumption is hard to guarantee. This implies that the "best" selected relay terminal according to channel condition during the route construction or handshaking period may not be the best one in the actual data transmission period. Selecting the best relay terminal based on the instantaneous location instead of instantaneous channel condition may be more reasonable for MANETs. In this paper, a distributed energy-aware location-based best relay selection strategy namely DEL-CMAC along with effective approach of cross layer with cooperative diversity is proposed. This can be explained that the location information of individual wireless devices can be obtained through localization algorithms. The required location information of source and destination is carried by RTS and CTS frames. Thus no additional communication overheads are involved. Using this proposed relay selection strategy, the energy consumption rate among the terminals can be balanced, and the total energy consumption can be primarily reduced.

5.2 Optimal Power Allocation

In a cross layer CMAC protocol optimal power allocation is extremely important aiming at increasing the energy efficiency. In this subsection, the power allocation for direct transmission and cooperative transmission is given under the given outage probability. The power allocation is done by firstly allocation the transmitting power at the source node in direct transmission which the destination calculates after receiving the RTS. Then, under the same outage probability and end-to-end data rate, in the cooperative transmission mode each relay candidate calculates the optimal transmitting power at source and relay after the RTS/CTS handshake.

5.2.1 Direct Transmission

The minimum transmitting power in order to meet the desired outage probability P^{O}_{D} , in direct transmission mode is given as :

$$P_s^D = -\frac{(2^R-1)N_0 d_{sd}^{\alpha}}{\ln(1-\mathcal{P}_D^O)}, \qquad (1)$$

Where, R is the transmission rate, d_{sd} is the distance between the source and the destination, α is the path loss exponent, h_{sd}
is the channel fading gain and N_0 is the variance of the noise component.

5.2.2 Cooperative Transmission

When the transmission power at source P^{C}_{s} equals to the transmitting power at relay P^{C}_{r}, then optimal power allocation for cooperative transmission exist. The equation is given by:

$$d_{sd}^{\alpha}\mathcal{G}(d_{sd}^{\alpha}+d_{rd}^{\alpha})-d_{rd}^{\alpha}\mathcal{G}(d_{sr}^{\alpha}+d_{sd}^{\alpha})+(1-\mathcal{P}_C^O)(d_{rd}^{\alpha}-d_{sd}^{\alpha})=0, \qquad (2)$$

where

$$\mathcal{G}(d)=\exp\left(-\frac{(2^{2R}-1)N_0 d}{P_s^C}\right).$$

5.3 Cross Layer Optimization with Cooperative Diversity

To improve the wireless links in wireless networks, the cooperative communication is known to be very effective way of exploiting the spatial diversity. To reduce the power consumption and to improve the reliability of reception, cooperative transmission is used. It encourages that the single antenna device must share their antennas cooperatively. Understanding such physical-layer technique, it is very important to know how the application performance can be increased by studying the concept of performance gain of cooperative diversity at physical layer can be exhibited in the network layer.

In ad-hoc networks, a severe problem of signal fading especially in case of multi-hop transmission is observed. If these issues are not considered, the signals will not be received properly. To deal with this kind of problem, the use of diversity provides better way to reduce the interference produced in signal. The main use of cooperative diversity is when the relays are used. The routing problem can be move from physical layer, MAC layer up to the application layer. a cross-layer approach has been shown to be an effective way in cooperative routing design. By using cooperative network power consumption is also reduced. A joint physical-MAC distributed approach and cross layer optimization for cooperative networks are shown to be effective for power optimization. use of cooperative diversity leads to increase in reliability in the network as well as throughput. For this purpose a node with best link quality meaning low power, high residual energy and whose SNR ratio is above the threshold is selected. It ensures that the sender node and the relay node share the same communication environment so that consistent decision can be taken while cooperation. Moreover, a node which has low mobility is preferred to be the relay node. The main use of cooperative diversity is that whenever any node fails while transmission, other nodes also have the same information with whom it is cooperated.

The existing DEL-CMAC gives low throughput although lifetime is increased but using effective cross layer optimization approach along with cooperative diversity while routing increases the network lifetime as well as the throughput.

6 Performance Simulation

6.1 Simulation Setup

The simulation tool used is Matlab. In this section the performance of the proposed DEL-CMAC together with effective cross layer cooperative diversity routing approach is evaluated by comparing it with previously proposed DEL-CMAC. The comparison is done on the basis of power consumed, throughput and network lifetime for both static and mobile environment. The transmitting denotes the total power consumed at transmitting the packet. The network lifetime denotes the time that the first terminal runs out of power. The throughput measures how well the network can constantly provide data to the sink. The throughput is the number of packet arriving at the destination per seconds. The environment considered is highly mobile with the pause time of 1 second which is much more mobile than the previous scenario where the pause time was 10 seconds in the mobile environment. The run time of each simulation is 20 seconds. The initial energy of all the terminals are set to 1 J. The data rate is 1 mbps for both protocols. The noise power is given as -60 dB. The simulation settings and parameters are given in table 1 .

TABLE 1
Simulation Parameters

RTS	160 bits	PHY header	192 bits
CTS	144 bits	MAC header	272 bits
ACK	112 bits	Noise Power	-60 dB
ETH	92 bits	Data rate	1 Mbps
II	80 bits	Initial energy	1 J

The evaluation metrics in this paper are the transmitting power , network lifetime, and throughput.

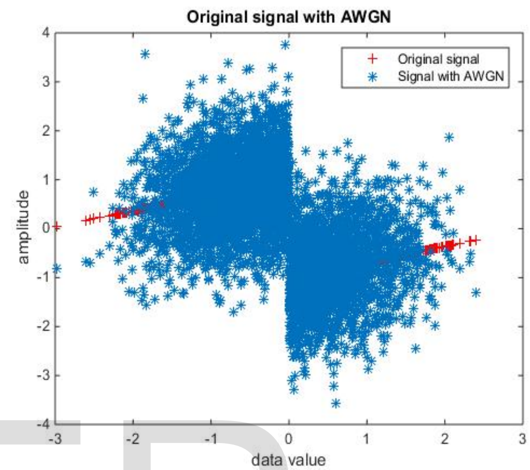

Fig.4. Amplitude versus Data Value

The above graph is plotted between the data value and amplitude. This graph shows the noise (AWGN- Additional White Gaussian Noise) added to the signal while transmitting. While transmitting, if the noise of signal is greater than the threshold value then direct transmission will consume more power and thus decreasing the network lifetime of MANET. In this case cooperative transmission takes place where relay nodes help in transmitting the signal to the destination.

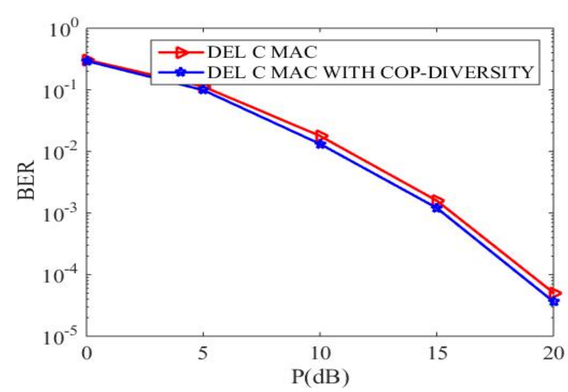

Fig.5. BER versus P(dB) for Mobile Environment

This graph shows the power consumption in both DEL-CMAC with cooperative diversity approach and DEL-CMAC without cooperative diversity. The graph is plotted for Bit-Error-Rate versus Power measured in dB. The above graph shows that using DEL-CMAC with cooperative diversity reduces power consumption as compared to DEL-CMAC without cooperative diversity in mobile environment. The decrease in power consumption means the increase in network lifetime because if the power consumption is more, the node transmitting the signal will fail earlier which leads to decrease in network lifetime.

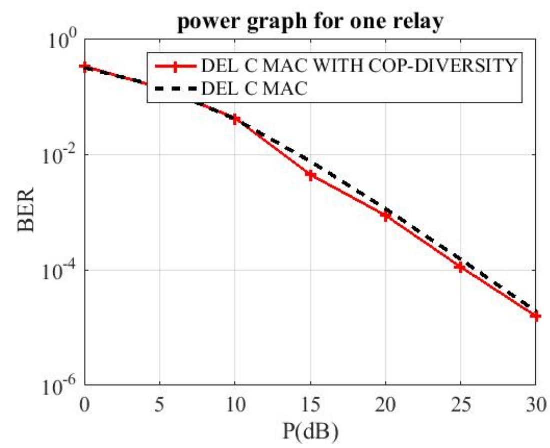

Fig.6. BER versus P(dB) for Static Environment

The above graph shows the power consumption in static environment. As shown in graph, the power consumption in static environment is also reduced by using DEL-CMAC with the cross layer cooperative diversity approach.

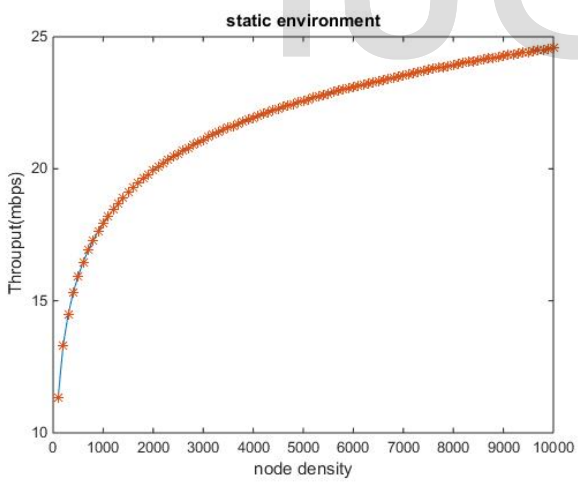

Fig. 8. Throughput versus Node Density for Static Environment

The above graph shows the throughput in static environment. As discussed earlier that use of cooperative diversity with the proposed protocol will increase the throughput of network, the above graph shows that even though the node density is increased the throughput is increased up to 20% more than the earlier system. In static environment the increase in throughput is more than the mobile environment with respect to the node density. This means the system performance is increased up to 20% than the original system.

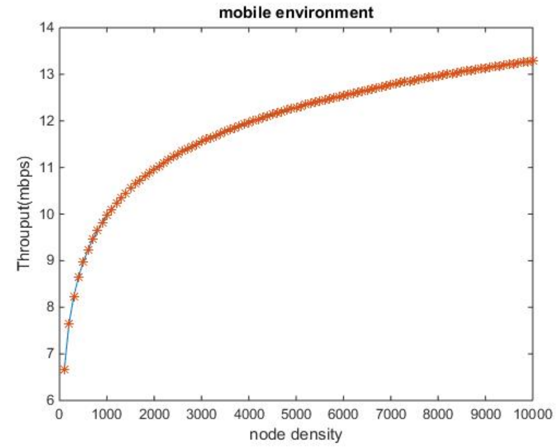

Fig.7. Throughput versus Node Density for Mobile Environment

The above graph shows the throughput enhancement in mobile environment with respect to the node density. It can be observed that the throughput has increased nearly 20% as compared with the original in case of mobile network due to effective cross layer approach with cooperative diversity in DEL-CMAC protocol. But it can be observed that in case of static environment the throughput was double than that of mobile environment.

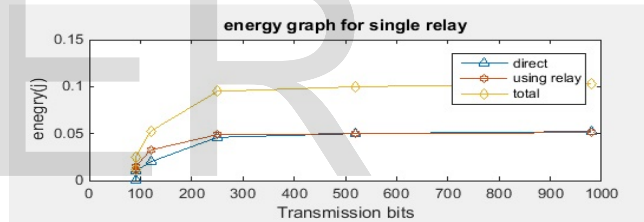

Fig. 9. Energy versus Transmission bits for Single Relay

The energy consumption is an important parameter of network lifetime. The total energy consumption of the network is calculated and the network lifetime depends upon that. As soon as the energy is depleted the network fails to transmit data. So the energy depends on the transmission bits. Even the relay selection is done on the basis of maximal residual energy of each node. The above graph shows the energy consumption with single relay node in the network.

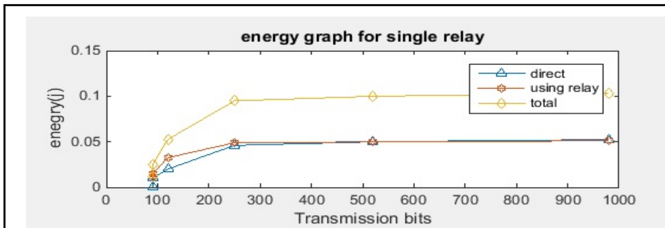

Fig. 10. Energy versus Transmission bits for Multi Relay

The above graph shows the energy consumption for multiple relays in mobile environment.

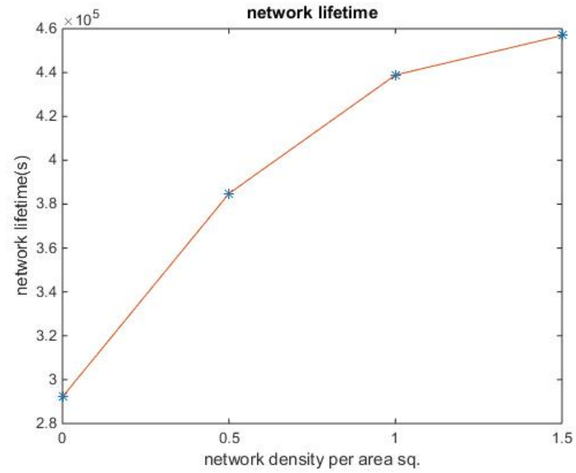

Fig. 9. Network Lifetime versus Networks Density

The above graph shows the increase of network lifetime with respect to the node density. This shows that that the use of cross layer with cooperative diversity routing approach together with DEL-CMAC leads to increase in lifetime of MANET which is the aim of this paper. The increase in network lifetime means the network will be active for longer time as compared to the earlier scenario. The network lifetime is increased up to 30-50% in proposed work. As a result the node failure will not occur soon and the network will work for longer time.

7 Conclusion

In this paper, a novel distributed energy-adaptive location based MAC protocol along with effective cross layer optimization with cooperative diversity routing approach is given for MANET. By using DEL-CMAC protocol the location as well as energy can be exploited. Cross layer approach is necessary because the power allocation is done in physical layer and routing in MAC layer, so to deal with the interaction of both the layers so that the properties of both the layers can be exploited, cross layer design was used. With DEL-CMAC cooperative diversity routing plays an important role in increasing the throughput and reliability of the system. Using cooperative diversity, diversity gain can be achieved. Cooperative diversity plays very important role in cooperative communication. As a result of combining the protocol with cross layer cooperative diversity routing approach leads to reduced power consumption which in turn increases the network lifetime of MANET from 30-50 % as compared to earlier scenario. The use of cooperative diversity helps in increasing the throughput of the network. The simulation results are shown for both static and moving environment.

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