RESEARCH ARTICLE OPEN ACCESS

Performance Analysis of Enhanced Opportunistic Minimum Cost Routingin Mobile Adhoc Networks

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ABSTRACT

Mobile Ad-Hoc Network (MANET) is a collection of wireless mobile nodes forming a temporary network with infrastructure less environment to establish a data transmission between nodes within the network. A routing protocol is used to discover routes between nodes. In this paper, we study the three existing routing protocols namely AODV, DSDV and DSR to analyze theirperformance based on set of parameters.AODV and DSR deliver almost all the packets compared to DSDV. Hence we try to modify the AODVprotocol and use in the cooperative transmission.

In this paper, we study the cooperative transmission at the network layer and cooperative diversity at the physical layer as a joint optimization of the transmission power in a Mobile Ad-Hoc Network (MANET) with static channel. However due to variable wireless channels static routing is suboptimal. Proposed protocol proactively selects forwarding nodes that work cooperatively forwarding the packet towards the destination.

Cooperative transmission side diversity helps in reducing interference. Diversity can be achieved at the physical layer by coordinating the multiple nodes. Nodes are equipped with Omni-directional antenna and take the advantages of transmission side diversity to achieve energy saving, under the assumption that channel gains are available at the transmitters.

The proposed **O**pportunistic **M**inimum **C**ost **C**ooperative **T**ransmission **S**hortest **P**ath (**OMCTSP)** algorithms select the best optimum route with minimum cost in terms of energy, number of hops, available bandwidth, link quality (SNR) and outage probability. As the network becomes larger, finding optimal routes becomes computationally intractable as the complexity of the dynamic programming (DP) approach increases as o (2^{2n}) where n is the number of nodes in the networks. Hence we develop two suboptimal algorithms have complexity of o (n2) perform as same as optimal algorithm. Also developthe Opportunistic Cooperative Routing in MANET (O_CORMAN), which is a network layer opportunistic routing scheme for mobile ad hoc networks. Nodes in the network use the components proactive routing protocol, forwarder list update and local re-transmission. We evaluate the performance using NS 2.32 simulator there is significant performance improvement with respect to energy, throughput packet delivery, and delay compared with Modified AODV (OMCTSP).

Index: Cooperative transmission, diversity, throughput, energy efficient route, delay, channel gain. , local retransmission, forwarder list update

I. INTRODUCTION

Energy efficient communication is a basic problem in wireless networks, particularly in ad hoc and sensor networks. In these networks, nodes are small and frequently spend maximum energy on communication [1].Nodes are typically battery poweredand have non-replenish able supplies resulting in a disconnected network. In wireless networks excessive transmission energy increases interference resulting in reduced throughput. Therefore over the past several years, this problem has receivedsignificant attentionseparately [1]-[6]at different layers of the protocol, notably physical layer and network layer. The goal at the physical layer is to find the energy efficient communication schemes and at the network layer is to find the energy efficient route selection algorithm for the wireless networks that minimize transmission power in an end-to-end setting.

At thephysical layer particularly, it is known that multiple antennas at transmitter or receiver gives more energy savings as compared to single antenna in wireless network [7].But the use of multiple antennas is impractical due to cost and increase in the capacity. The above problem is solved by allowing cooperation among spatially distributed single antenna for the wireless medium, the so called cooperative communication [8][9].The mutual information and outage probability of the network are analyzed. However in this wireless model, the relay nodes require to decode their received signals.

In a cooperative communication omnidirectional single antenna is used, the signal transmitted by the source node is received by all nodes within a coverage area. For examplein Fig1**,** the source node S transmits is received by both nodes 1 and 2.This property is called as *wireless broadcast advantage(WBA).*Another property of the wireless medium is *wireless cooperation advantage* (WCA) is the space diversity at the physical layer. Diversity can be achieved by coordinates multiple antennas resulting that reduces the error probability. In our paper, we have assumed that nodes are equipped with single antenna. Several nodes can cooperate with each other to transmit the information to other nodes, these cooperation achieve similar energy savings as multiple antenna scheme [10]. The energy savings due to cooperative transmission by several nodes is so called WCA

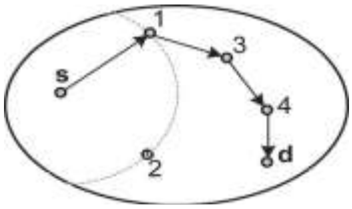

Fig 1: wireless broadcast advantage property

Fig 2 shows the cooperative diversity of the wireless network. The routing protocols point-to-point link and multi-hop link are used to transmit a signal from source node to destination node. Multi-hop link combines the transceiver transmission results that produce increasing SNR or decreasing SNR .These fluctuations occur across both frequency and time, also wireless channel variations called as fading, shadowing, and other forms of interference. Using diversity, the channel interference due to fading is reduced and increases the reliability of the wireless network [10],[11].

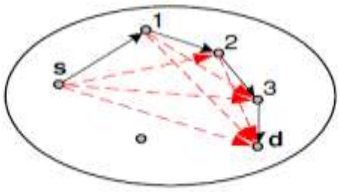

Fig 2: Cooperative Diversity

O_Corman is a pure network layer opportunistic routing scheme for mobile ad hoc networks. It has three components such as 1.proactive source routing protocol (PSR) to determine a list of intermediate nodes so that each forwarding node has complete knowledge of route that forward the data to all other nodes at any time in the network.2O_Corman is a pure network layer opportunistic routing scheme for mobile ad hoc networks. It has three components such as 1.proactive source routing protocol when the packet of data is forwarded along the new route, updated route information propagated by an upstream node without any additional overhead. As a result all upstream nodes have information about new route faster than periodic route exchange scheme 3.Small-scale retransmission of missing packets, nodes that are not listed as forwarders hence to retransmit the data if the downstream forwarder has not received these packets. Fig 3 shows the packet route between nodes*X* and *Y* as determined by the routing module is indicated by the yellow band. The solid circles represent the listed forwarders and the hollow ones are the small-scaletransmitters. In actual operations of O_CORMAN, packets *p*1, *p2*, and *p*3 can take separate routes around this band depending on the transient link quality in the network. Such a decision is made on a per-hop and per-packet basis

Fig 3: PacketPath

Aim of this paper is to take advantage of the wireless broadcast property and the transmission side diversity created through cooperation to reduce the end-to-end energy consumption in routing the information between two nodes optimal static routing algorithms to find minimum energy routes in a network. We derive a Opportunistic cooperative routing, and evaluate their performance using NS-2.32simulator.

This paper is structured as follows, In Section II, we describe our system model and formulate cooperative link cost in terms of transmission power. Section III, presents our cooperative routeselection. Simulation results are discussed in Section IV. In Section V conclusions and future research works are discussed.

II. SYSTEM MODEL

The wireless network consisting of N nodes and it is distributed randomly in an area, where each node has a single omnidirectional antenna. We assume that each node can adjust its transmission power and multiple nodes can coordinate their transmissions at the physical layer to form a cooperative link. So beam forming is not performed, only rough packet synchronization is required [12]. We model point to point transmission as multiple MISO transmission, using point to point transmission we formulate energy consumption in a cooperative MISO transmission.

A. Channel model: Fig 4 shows that cooperative channel model, we consider a time-slotted wireless channel between source and destination nodes, and assumed that channel is characterized by channel gain h_{ij} captures the mixed effects of symbol synchronism, multipath fading, shadowing and path-loss between the two nodes. Let t time-slot the transmitted signals be $x_i[t]$ and received signals be Y_j [t] , pair of transmitting node t_i ε T and receiving noder$_j$ ε R and remaining nodes are serves as a relay nodes (i.e.) N-2 nodes in a N nodes. We assume that channel gain is inversely proportional to the distance between the communicating nodes Power of pathloss. The receiver node will receive the signal in a two different phases which is transmitted by transmitting node.

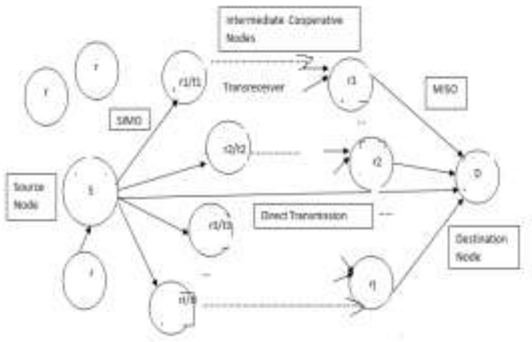

Fig 4: Cooperative Channel Model

Phase I: At first time slot the transmitting node i transmit with power $p_{s1,}$and all other relay nodes and receiving node will listen[13],[14]. The transmitted signal xs_1 (t) and noise is η_j (t) received at r_j, it is assumed to be complex additive white Gaussian with power density P_{nj} .Then the received signal between i and j node is

$$\mathbf{Y_{ij}} = \sqrt{\mathbf{ps1}(\frac{h_{ij}}{d_{ij}^{\propto}})}\mathbf{*xs1\ (t) + \eta j\ (t) i =1,..n\ \&j = 1,\ldots m} \quad (1)$$

Where h_{ij} is the channel gain of i and j nodes, d_{ij} is distance between transmitting node i and receiving node j and ∝ is the path loss exponent.Similarly the received signal at node k and noise is $\eta_k(t)$ received at r_k,

$$\mathbf{Y_{ik}} = \sqrt{\mathbf{ps1}(\frac{h_{ik}}{d_{ik}^{\propto}})}\mathbf{*xs_1\ (t) + \eta_k\ (t)\ i=1.,n\ k= 1,.N-2} \quad (2)$$

Where h_{ik} is the channel gain of i and k nodes, d_{ik} is distance between transmitting nodes i and receiving (intermediate) node k.

Phase II: At second time slot the relay node k transmit signal xs_2 (t) to destination node j with power pj∈ D.p_{s2} is the power of source node in phase II, and noise is η_j (t) received at r_j, it is assumed to be complex additive white Gaussian with power density P_{nj} [38, 39] .Then the received signal between k and j node is

$$\mathbf{Y_{kj}} = \sqrt{\mathbf{P_{s2}}(\frac{h_{ij}}{d_{ij}^{\propto}})}\ \mathbf{*xs_2\ (t) + \eta_j\ (t)} \quad (3)$$

The original transmitted signal combines [15] both the signal received from source and the signal received from relay

$$\mathbf{Y_j = [Y_{ij}, Y_{kj}]} \quad (4)$$

If the received signal-to-noise ratio (SNR) exceeds a prescribed decoding threshold η, the received message can be decoded correctly. Let D denote the decoded set that includes all the nodes whose received message can be decoded properly. p_{s1}, ps2 are the power allocated to transmitter at phases I and II respectively. The total transmitted power is P_T= Ps_1+$Ps_2$and wehave SNR at receiver node j ε R is

$$\mathbf{Snr_{ij}} = \frac{|h_{ij}|^2}{d_{ij}^{\propto}} * \frac{P_T}{P\eta j} + \sum_{k\in D} \mathbf{p_k} * \mathbf{h_{j,k}} \quad (5)$$

Where$p_{\eta j}$is receiver noise power, h_{jk} and h_{ij} are channel gain between node j and k, node i and j respectively and p_k node k power

B.Routing Model*:* A K-hop cooperative route l is a sequence of links ‘k’ is {l_1……. l_k, where each link is formed between transmitting node T_k and receiving node r_k is l_k = (t_k,r_k) using two stage cooperative transmission. Our objective is to find the route that minimize the end-to-end transmission power.

Definition 1 (link cost LC): The link cost between transmitter t_k and receiver r_k is denoted by LC(t_k,r_k) defined as the minimum power deliver the message from t_k to r_k using two stage cooperative transmission is subjected to throughputs, bandwidth, outage probability, no of hops. The energy efficient routing can be formulated as follows [13]

$$\text{Min} \sum_{lk\in l} \text{LC}(t_k, r_k) \quad (6)$$

$$\mathbf{LC(t_1, r_1)} = \widehat{PT} = \frac{\mathbf{SNRmin*p\eta j}}{\alpha^2} \quad (7)$$

In MISOthe receiver combines the received signals, and complete decoding is possible as long as the received SNR is above the minimum thresholdSNRminfor all nodes in R. Now the received signal at receiver r_j is

$$\mathbf{Y_j} = (\frac{h_{ij}}{d_{ij}^{\propto}})^{\mathbf{T}}\mathbf{*w+\eta j} \quad (8)$$

Where w is a scaling factor, ηj noise at node j and $(\frac{h_{ij}}{d_{ij}^{\propto}})^{T}$ is transpose of vector gain

The resulting optimal power allocation for each node *i* is given by

$$\widehat{wi} = \frac{\left(\frac{h_{ij}^*}{d_{ij}^{\propto}}\right)}{\sum_{i=1}^{T}(\frac{h_j}{d_{ij}^{\propto}})*} \quad (9)$$

The resulting cooperative link cost LC(T,r_1), given by

$$\mathbf{LC(T,r1)} = \sum_{ti\in T} w_i^2 = \frac{\mathbf{SNRmin*p\eta*}}{\sum_{ti\in T}\left(\frac{h_{ij}^*}{d_{ij}^{\propto}}\right)^2} \quad (10)$$

The above equation can be written in terms of the point-to-point link costs between all the source nodes and destination nodes, given by

$$\mathbf{LC\ (T,r1)} = \frac{1}{\frac{1}{\frac{SNRmin*p\eta*}{\left(\frac{h_{i1}^*}{d_{i1}^{\propto}}\right)^2}} + \frac{1}{\frac{SNRmin*p\eta*}{\left(\frac{h_{i2}^*}{d_{i2}^{\propto}}\right)^2}} + \cdots\ldots + \frac{1}{\frac{SNRmin*p\eta*}{\left(\frac{h_{in}^*}{d_{in}^{\propto}}\right)^2}}} \quad (11)$$

It can conclude that the transmitted signal is proportional to path loss attenuation therefore all nodes in the reliable set cooperate to send the information to a single receiver .Also the cooperative cost is smaller than each point-to-point cost. Hence it proves that always cooperative transmission saving more energy by taking the advantages of WCA.

III. COOPERATIVE ROUTE SELECTION

A.OMCTSP algorithm

Modified AODV routing protocol is a reactive protocol, Routes are established on-demand, as needed. Nodes receiving the packet update their information for the source node and set up backwards pointers to the source node in the route tables. In this paper we have considered Cooperative Transmission Communication with Wireless Channel Variation. Hence each forward node calculates channel gain and for successful transmission the channel gain is above the threshold SNRmin.The Relay Selection can be done in two ways

Minimizing the total transmitted power: The channel gain vector calculated between transmitters and the super node. The nodes which will decode successfully are called super node.

Maximizing the Total Transmitted Power: Among all the receiver nodes whichever is the highest channel will be the channel gain.

Procedural steps for implementing OMCTSP algorithm is as follows.

Step1. First modify the MAC layer protocol 802.11 to include SNR calculation.

Step2. Next modify the routing protocol AODV.

Step 3. Network is randomly distributed with defined no of nodes with specified initial energy.

Step 4. SNR value is estimated, and nodes that all decoded properly, while receiving the hello message and it is stored in SNR table.

Step 5. Unit variance model estimates expected value for channel gain for each slot index. Once the square of expected value is 1 then outage probability is estimated, when the mutual information as a function of the fading coefficients become a Random Variable. If the probability of error or Outage probability value is 0 then the channel is not in outage and outage probability value is 1 then the channel is in outage.

Step 6. Every node goes for calculating available bandwidth and also the number of hops for each path is calculated.

Step 7. The source node when sending the route request packet, will include outage probability, residual power available and available bandwidth, size of the packet.

Step 8.Intermediate nodes updates the link cost based on point to point connection.

Step 9.All the forwarding nodes will compare SNR value of its received packet, its available bandwidth, residual energy and also number of hop.

Step 10. When the destination node receives the route request packet, it selects the best path based on four parameters.

Step 11. Once a best path is selected, the destination node Generate route reply message and send it into source by reverse path.

Step 12. This calculation goes on for all the packets forwarded towards the receiver. So that whenever the receiver finds a better path, it discards the old path and picks up the new path for data communication.

Modified AODV is also suffered from limitations like it cannot do opportunistic data transfer in MANET. To solve this problem, protocol called as O_CORMAN was presented which can do opportunistic data transfer in MANET. AODV is a good performance driven routing protocol in all kinds of network scenarios. But practically O_CORMAN shows the good performances as compared to the AODV routing protocol

B.O_Corman algorithm. The design of O_CORMAN has the following three modules.

1. Proactive source routing — PSR runs in the background so that nodes periodically exchange network structure information. It converges after the number of iterations equal to the network diameter. At this point, each node has a spanning tree of the network indicating the shortest paths to all other nodes. PSR is inspired by pathfinding [16], [18] and link-vector [17] algorithms but is lighter weight.

2. Forwarder list adaptation: The source node has knowledge about the network within its coverage area, but due to mobility of node in dynamic channel the source node does not have the updated knowledge .Hence this can be overcome by means of every intermediate nodes have the ability to update the forwarded list. First using this new route date packet can be forwarded that it has already received, without any extra overhead the updated information is propagated upstream rapidly. Hence all forwarder knows about the new route. Second replaces an updated forwarder list in place of old list in the packets. Third this updated information is send back to source by downstream. Data forwarding and list update are described

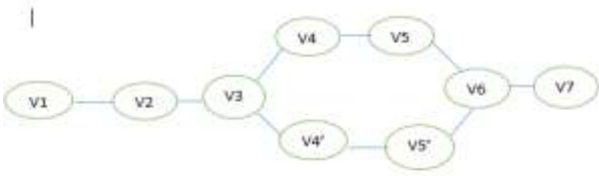

Fig 5: Data Forwarding

Fig 5shows the live route update when a batch of packets are forwarded along the route towards the destination node. The source node *v*1 has data packets forward towards the destination node v_7 and then v_1 decides that the best route to v_7 based on SNR value of its received packet, its available bandwidth, link cost, residual energy and also number of hop. Intermediate nodes updates the link cost based on point to point connection. Hence the forwarded list is $v_1,v_2,v_3,v_4,v_5,v_6,v_7$

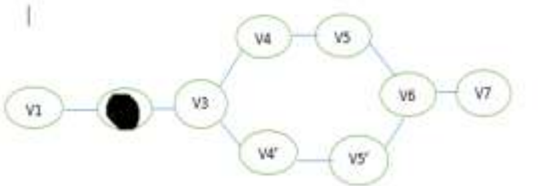

Fig 6: Frontier Node

Fig 6 showsthe frontiernode, when a batch of packets are forwarded towards the destination node. At a particular given time forwarder list that has highest priority is called as frontier of the batch and has receive any packet of the batch. Initially source node is thefrontier, in this figure suppose v2 is the frontier the new route to the destination $v_1,v_2,v_3,v_{4'},v_{5'},v_{6'},v_{7'}$ and its replace the original forwarding route.. The nodes can update their own routing information and will incorporate such information when forwarding their fragments. When the network coverage area is large and nodes are moving fast, the information can become out of date by the time it is propagated to a destination node. When the destination node is far away the nodes has less knowledge about the network topology. The forwarder list is collected by the source node and adjusted as packets are sent to the destination node, where intermediate nodes nearer to the destination node have better information about routing. This is accomplished by modifying the forwarder list by frontier node. Hence the o_corman has a better tolerance of inaccuracy in route for source node.

3. Small-scale retransmission: A short forwarder list is forced to forward the packets to the destination over long distance with weak links .O_corman coordinates retransmission attempts among nodes efficiently in order to increase the reliability of data forwarding by mechanism of retransmission of data packets if not received successfully. For example in fig f1 and f2 are the two consecutive forwarder in the list and node r is located between f1 and f2 .By comparing the packets transmitted by f1 and f2 the node r knows which packets are missed by f2 and now retransmit these packets. If there are two nodes r and r_ in this area O_corman ensures that at least one such node should retransmit. . In this case for node r to be a retransmitted, should satisfy the following conditions.

Fig 7: Retransmission

Fig 7 shows the retransmission. Node r should be a neighbor of the f1 and f2.The distance between f1 and f2 is d (f1, f2) should be more than d (f1,r) and d(r,f2).The node distance can be determined by using RSSI(Received Signal Strength Indicator) .

Node ‘r’ uses any function such that scoring function F (d (f1,r),d(r,f2)) favors a node located close to the midpoint between f1 and f2 and not close to either one of them measures how suitable as a retransmitted for f1 and f2.Node r can also be measure the suitability value by RSSI measurements for all other nodes in N(r) to satisfy the above two conditions.

IV. PERFORMANCE ANALYSIS

Packet Delivery Ratio

It is the ratio of the number of delivered data packet to the destination. This illustrates the level of delivered data to the destination.

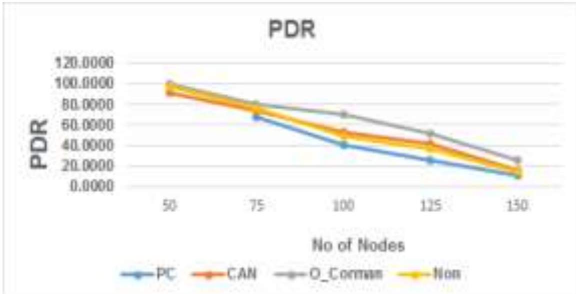

Fig 8: PDR Vs Nodes

Fig 8 shows the packet delivery ratio for cooperative algorithms of both Maximum and Minimum transmitting power of dynamic channel with OMCTSP, O_corman and staticchannel for various No of nodes. The O_corman algorithm delivers more packets than the all other dynamic channel cooperative algorithms and as also compared with static channel cooperative transmission.

Average Consumed Energy

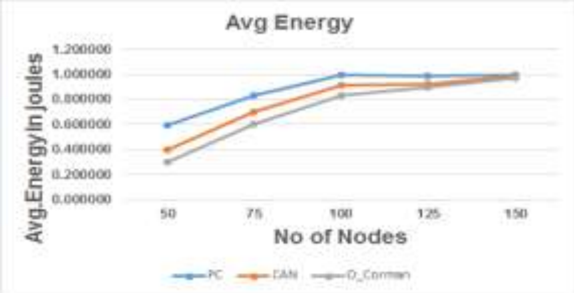

Fig 9: Average consumed energy Vs Nodes

Fig 9, shows average consumed energy for cooperative algorithms O_corman, Dynamic channel and static channel network of OMCTSP algorithm for different number of nodes. Static channel consumes more energy than OMCTSP and O_corman. Also compared O_corman with OMCTSP, it consumes more energy than OMCTSP algorithm.

Total Energy Consumed.

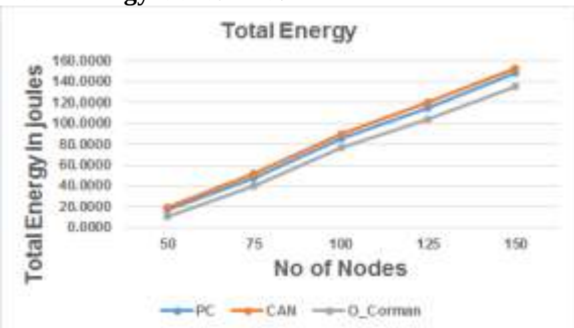

Fig 10: Total Consumed Energy vs Nodes

Fig 10, shows total consumed energy for different nodes of different cooperative algorithms like O_corman, OMCTSP and Static. Static channel network consumed more energy than compared with all other algorithms and also compared with OMCTSP O_corman consumed more .

Throughput

Throughput is referred to as the ratio of the total amount of data that a receiver receives from a sender to the time it takes for the receiver to get the last packet. A low delay in the network translates into higher throughput. Delay is one of the factors effecting throughput, other factor is routing overhead. Throughput gives the Utilization fraction of the channel capacity used for useful transmission and is one of the dimensional parameters of the network.

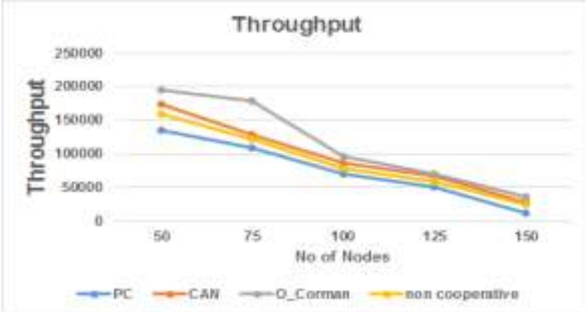

Fig 11 Shows the Throughput for various nodes. The throughput in O_corman improves more than all other cooperative transmission.

V. CONCULSIONS

In O_coremn the upstream nodes should not be disrupted by the new route so that coordination among the nodes js maintained by replacing only the segment of list between frontier and destination. To avoid unnecessary updates of route information only a frontier node is allowed to update a packet's forwarder list according to its routing module, as the time available to transfer a batch of data packets is very short. Consider a particular intermediate node on the forwarder list, the forwarded list is updated every time by various frontiers as the frontier moves from the source to the destination, thus, this node may experience one update about its route to the destination every time a frontier decides to modify the list. All of the above is achieved rapidly and with no extra communication overhead

VI. FUTURE SCOPE

To improve the network capacity of Mobile Adhoc Networks with cooperative communications, have proposed a Capacity- Optimized Cooperative (COCO) topology control scheme that considers both upper layer network capacity and physical layer relay selection in cooperative communications dynamic traffic patterns in the proposed scheme to further improve the performance of MANETs with cooperative communications.

This research are converting the cooperative node as selfish node. The selfish node stops forwarding the conventional packets to the endpoint and find another path to reach the endpoint directly. With this method the capacity of network is increased when compared to Cooperative Communication Capacity Optimized Cooperative topology scheme is introduced. Increase in data rates, reduction is packet loss, reduction in packet delay and increase in network capacity is achieved using COCO Topology scheme. Increase in node density. On comparison of the throughput for both OMCTSP algorithm gives more than static channel

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