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Resolving Inherent Node Misbehaving of Node Cooperation Enhancement Scheme

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ABSTRACT

Most of the existing network operations in MANETs assume that mobile nodes owned by same or different users will follow prescribed protocols without deviation, however, due to the ad-hoc inherent characteristic issues ICI: like open structure topology, no infrastructure, scarcely available battery-based energy, short of availability of bandwidth (network resources) which significantly depredated network performance under fading channels. Therefore, during network operation nodes tend to misbehave due to several reasons resulting from network inherent issues. These nodes' misbehaving can either be intentional misbehaving (caused by nodes themselves) or unintentional misbehaving mostly caused by network inherent issues (wireless environment impairments). Intentional misbehaving as been slightly resolved by using Incentive mechanisms but that of the unintentional misbehaving for maximum node cooperation is not. Hence, stimulating and enforcing the cooperation among nodes to resolve unintentional misbehaving becomes a very important issue, and the issue is not just only to develop mechanisms (incentive procedures) to enforce cooperation among nodes but to address network inherent challenging issues that made nodes not to cooperate i.e. misbehaving. Several different approaches we referred to as Incentive Mechanisms: virtual currency mechanism, reputation based mechanism and game theoretic mechanism (IEEE 802.11 based). Needed cooperation can't just be enforced by using these incentive procedures but by incorporating some combination diversity techniques which can help in reducing or improving the wireless constraints nature of MANETs. In this paper we propose a complete system framework for MANETs NoCo-DCDT MAC node cooperation mechanism incorporating diversity techniques which first address the network ICI of MANETs by creating multichannel medium, cooperative channels by conveying packets from source to a destination through multiple intermediate nodes with higher order modulation to improve channel relaying and routing by achieving significant power savings, getting rid of unintentional misbehaving attitude of nodes, and pave a way to enhance effective nodes cooperation.
The simulation results show that with the proposed scheme, ICI which are the major cause of ad-hoc node misbehaving are addressed and solved by the tremendous (throughput improvement) in the relaying and routing of data packet, less delay in transmission and higher packet traffic delivery ratio.

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INTRODUCTION

A mobile ad-hoc network is a wireless multi-hop multi-routes network formed by a set of mobile nodes in a self organizing and dynamic way without relying on any established infrastructure. MANETS are made of the following Inherent Characteristic Issues (ICI): open structure topology, scarcely available battery-based energy limited resources such as energy, bandwidth, computational power, mobile nodes in MANETs may move freely in the absence of a fixed infrastructure, and changes in forwarding and relaying of packets may occur due to unpredictable topology changes and link disconnections, which set in unintentional misbehaving. Because of these characteristics all networking functions must be performed by the nodes themselves, i.e. packets sent between two distant nodes are expected to be forwarded by intermediate nodes, the node does route discovery for other nodes, each node relies on its neighbor to forward the packet to the destination node, all these processes are made possible by what is called Node Cooperation schemes which are at times impossible due MANET ICI. Due to ICI already proposed node coop schemes have no solutions to this unintentional

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misbehaving, and there is this saying “No amount of incentive procedures can improve the relaying wireless environment of MANET,” except what we opt for in this paper.

There are lots of papers on this subject of different schemes in node cooperation enhancement, they include (a) Virtual Currency Based Mechanism (Incentive-based Mechanisms): (Zhong, S., 2003) and (Buttyan, L. and J.P. Hubaux, 2001), (b) Reputation and detection Based Scheme: (Buchegger, S., J.Y. Le Boudec, 2002) and (Michiardi, P. and R. Molva, 2002), (c) Game Theoretic Models: (Felegyhazi, M., 2003). Part (a) are based on the idea of virtual currency, a virtual currency is used to charge/reward the packet forwarding service nodes i.e. a price being paid to a node that does packet forwarding services and charge a node that does not, and the node can use the amount being paid to it for its own service too. Part (b) are base on the behavior of nodes in the network, its objective is to enable node to realize the changes that a selfish node cause in the network, so the scheme abandon bad behavior nodes by not allowing or using them to for relaying and routing. Part (c) is base on model with/without incentives schemes, with incentive the node cooperation in MANET are treated as a cooperative or non cooperative game. It is used to derive optimal strategies (Nash Equilibrium) under certain conditions (typically energy constraints). While without incentive it model by first considering network topology i.e. finding theory condition for cooperation there is existence of out of self-interest. We described: Unintentional misbehaving as mischievous attitude that inherently build up in a decentralized network like ad-hoc network due lack of adequate infrastructure for packet routing and relaying, this issues make node to see each other tending to misbehave even when it’s not misbehaving. It might be because the node power is already low or fading impairment and so such node can’t do forwarding activities but want to be in the network, such node might be seen by its neighbor as being selfish whereas it’s not. It is unintentional misbehaving that set-up intentional misbehaving. Intentional misbehaving are mischievous attitude that are selfishly build up in a decentralized network like ad-hoc network due lack of node self-control meaning to intentional obtain help from the network without showing the willingness to pay back the received help. These are already fixed with above Incentive mechanisms. It is unintentional misbehaving that set in intentional misbehaving.

In this paper, we propose and design a complete node cooperation enhancement scheme Noco-DCTDMAC with cooperative relay framework for wireless ad-hoc networks that leverages these inherent characteristic issues (ICI) to increase the overall communication reliability within similar cost constraints as traditional techniques to tackled unintentional misbehaving.

Limitations Node Cooperation Enhancement Schemes:

Virtual currency payment schemes despite the power usage and effort making selfish nodes forward for others. These approaches make it undesirable for selfish nodes to deny forwarding. They do not, however, target other types of misbehavior. There is no improvement done to Ad-hoc inherent characteristic issues.

In detection and reputation based schemes, secure routing using cryptography, such as providing preventive means for specific malicious attacks, e.g. compromising routes. Once a route is found, its use is not secured. Secure routing solves a part of the question, but not all. There remains a variety of observable types of misbehavior that they cannot cure easily, such as silent route changes, which may be addressed by detection and reputation systems.

In game-theoretic terms, cooperation in mobile ad-hoc networks poses a dilemma. To save battery, bandwidth, and processing power, nodes should not forward packets for others. If this dominant strategy is adopted, however, the outcome is a non-functional network when multi-hop routes are needed, so all nodes are worse off thereby decreasing network performance. Depending on the proportion of misbehaving nodes and their strategies, network throughput decrease, packet loss, denial of service and network partition can result.

In general, the models upon which these above schemes are based proved their potency and how effective they are used to enforce and simulate cooperation in MANET but they did not first addressed what make a node to be selfish, malicious i.e. misbehaving due to wireless channels are often poor and degradation, i.e. the inherent characteristic issues. These issues lead to intentional and unintentional misbehaving, at times a node may not participate in network activities due to poor wireless condition but its neighbor might think it intentionally refuse participation, such issue here cannot be tackled by incentive mechanisms. No amount of incentive means will improve the wireless nature of MANETs environment, so that is why we opt for a new method of incorporating DCDT MAC node cooperation enhancement. The mechanism of node cooperation in this paper first addressed the inherent issues characteristic of MANET that affect it, by employing the concept of diversity techniques communication between multi-hop nodes for conveying and relaying packets to a destination through multiple intermediate nodes, which other mechanisms did not consider, and also the use of DF and CF and higher modulation order at relay nodes.

Problem Statement:

It is known that MANET have lots of shortcomings due to ICI , absence of infrastructures despite their usefulness in an area where infrastructural communications are not available e.g. disaster environment, military war zone, Since the problems involve inherent issues like no *defined network topology, power constrained,*

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network resources issues, i.e. how node energy use can be minimized, how nodes receiving and transmitting antenna can combine spatial, relay node mobility can be coordinated for selfishness and misbehaving to be eliminated. These issues made node in MANET to misbehave (selfish and malicious) thereby not forwarding and relaying packets for its neighbor, so cooperation among nodes is hard to come by, no amount of incentive procedures can resolve these, so we opt for what is proposed in this paper. These issues result into unintentional misbehaving as a result of MANET wireless environment impaired. There is no way a good incentive cooperation scheme like above can stimulate, enforce and encourage nodes with inherent characteristic issues ICI to cooperate.

Diversity Techniques: Terms:

Spatial (Cooperative) diversity:

This section describes the concept that our scheme incorporate to address factors or issues of node non-cooperation and then stimulate node cooperation in MANET. Cooperation diversity exploits the spatial diversity of the relay channel by allowing different mobile terminals to cooperate. In this context, we envisaged the formation of *virtual antenna arrays* without requiring installation of multiple transceiver antennas i,e nodes need not to be MIMO enabled. It is largely based on relaying messages; its information-theoretical foundation is built upon the landmark 1979 paper of Cover and El Gamal (Cover, T. and A. El Gamal, 1979). The idea of the concept (creating multi-hop communication) is to break long original communication link btw two nodes into two or more shorter links, and thus could reduce the required transmission power of each node participating in the communication scenario which in turn leads to a lower interference level and shorter BW range. The cooperation diversity is done at the relay channel environment

Relaying channel:

The relay channel three-terminal communication channels i.e. source communication to the destination is a three-node channel, with the help of an intermediate relay node, it is either full duplex (i.e. transmit and receive simultaneously on the same link,) or half duplex (transmit and receive differently on the same link) channel. The distinctive property of relay channels in general is that certain terminals, called relays", receive, process, and re-transmit some information bearing signal(s) of interest in order to improve performance of the system

Fig. 2.1: Pictorial illustrations of Wireless Tx/Rx diversity techniques.

Reputation Base Function RBF:

RBF is a trust and distrust function opinion about an entity. It is considered as a component of identity of a node as defined by others and is seen to reside in the negative and positive belief or report that nodes hold toward other nodes (cognitive node) and the knowledge feelings that a node in the network have toward another (affective node). It gives an indication of whether node like, admire or trust neighboring and its attributes (well behave, selfishness, malicious, route discovery, path selector, path observer). Some terms related to RBF are defined below.

Global Reputation Protocols:

Each node in this class updates reputation value using two information: direct observation and valid reputation message from other nodes.

Local Reputation Protocols:

Here only local reputation information is used to update the reputation value for the neighbor node. The protocols assume that each node knows its neighbors and maintains a reputation value for each one.

One Hop Reputation (between two nodes):

This is a type of reputation exists between two nodes .i.e. a pair node direct reputation, it could be promiscuous pair or un-promiscuous (discuss below), the two nodes involve have a complete knowledge about themselves than other node two three hope from them.

Gains Expected in DF and CF higher order modulation:

Here we introduce a higher order modulation (Mustapha Benjilali, 2010) at the relay nodes for improvement in relaying gain. For higher order modulation (2mr-ary modulation) done at the relay nodes i.e. modulation at the relay node higher than that of source node, the idea is for the relay to listen longer before

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forwarding (relay receiving time $\alpha 1 > ½$), the new relay receiving time $\alpha 1$ and $\beta 1$ for the relay to listen longer the spectral efficiency of the transmitter

$$\alpha 1 = mr1/ms + mr1 > 1/2,\ \beta 1 = mr2/ms + mr2 > 1/2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (7)$$

(Where ms = source modulation scheme mr = relay modulation scheme)

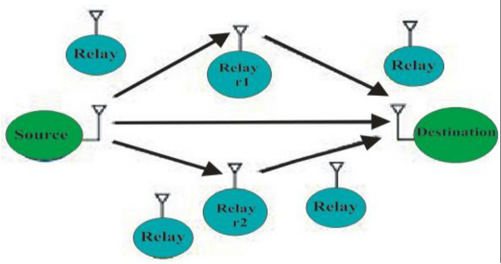
of the transmitter is improved. Analytically, base on average source-destination SNR where the relay is at the mid-point of S and D, conventional *mr = 1, ms = 1* modulation at source is same as relay i.e. *BPSK – BPSK,* our scheme *mr = 2, ms = 2* modulation of relay is higher than source i.e. *BPSK – QPSK.* The mostly widely used modulation schemes are *BPSK and QPSK, since QPSK has higher performance than BPSK according this [], we then adopt QPSK in the relay node (implemented in NS2). The use of* QPSK at the relay can transmit twice the amount of data on the same channel with the same bandwidth. If QPSK is able to make extension of its modulation by QPSK by 8QPSK, 16QPSk and 32QPSK, then there is a higher data rate achieve by little increase in BER comparing to BPSK and high SNR with a less noise in the channel when transmitting.

System Model:

It considers a distributed random placed mobile ad-hoc network with N mobile nodes, each single antenna node. Some transmission diversity features are considered at the physical layer: spatial cooperation (relay repeat transmission) i.e. antennas diversity, higher order modulation, relying strategies coding schemes (DF and CF) and Rx/Tx cooperation. A multiple channel with half duplex transmission approach is assumed.

For data transmission between source S and destination D, 2-3 relays nodes serves as helpers) are selected for cooperative transmission, because we believe not all relay routes channel between S and D will be good, so in support at MAC layer we build a routing protocol (DRP) using multi-user diversity to select a HQ, max SNR selection and discovery of route base on single and promiscuous pairing channel state info between nodes. Two chosen relays are denoted as *R1, R2 and R3* shown in figure below, where n =2 or 3. Note for cooperative transmission relays are needed to overhear transmission and retransmission when direct transmission fails or not possible, multi-hops nodes involve the use of relaying. We use DF and CF when *source-relay SR* and *destination-relay DR* nodes are respectively in a close proximity to each other, relay nodes with higher order modulation e.g. QPSK, Our idea here is a way to reduce node misbehaving by increasing cooperation because for direct transmission it means no relays, no node misbehaving.

In addition to this work, we use a reputation Base Function RBF as a node cooperation enforcer by punishing and rewarding intentional attack aiming nodes, which motives are to attack in the network. We use the RBF along with a creative technique called pairing function i.e. pairing of two objects or nodes. The techniques setup and negotiate the selection of relay routes by incorporating into the MAC and routing protocols which will be discussed in detail in section.



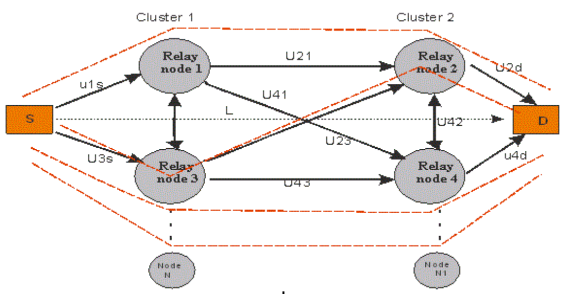


Fig. 3.0: Relay models diversity techniques scenarios. **Fig. 4.0:** System architecture.

We depict the above diagram as a MANETs environment, in MANET environment at physical layer, there two types transmission models, they include: direct transmission (L), multi-hop transmission (between node S, Relay node 1, relay node 2 and the D) and cooperative transmission (shown in red line), The relay nodes are in a distributive placement of 1 and 2, due to long distance L Source node S is not in the range of D so the distance can be shorten by using relays nodes. The modeling of these relays channel is base on how the node relays message within their selves. From the above diagram it can be seen that node 1, 3, and 2,4 can send and receive same time (full duplex), if T_{x1}, T_{x3} and R_{x1} R_{x3} cooperate perfectly, while nodes 3 & 2, 3 & 4, 1 & 4 can receive and send at different time (half duplex), where U_{1s},U_{3s}, U_{41}, U_{21}, U_{31},U_{4d}, U_{2d} are assumed to be there independently distributed Rayleigh flat fading coefficient (AWGN, zero mean, major degradation of wireless channel). Base on the channel modeling, combining nodes number of Tx to number of Rx to form virtual MIMO (i.e. 2 to 2 antennas).

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Proposed Protocols Modeling:

We develop a simple model in a MANET environment to predict or demonstrate how unintentional misbehaving occur due to inherent characteristic issues which then lead to intentional misbehaving: we denote node misbehaving *(nM)* as *intentional misbehaving (iM)* and *unintentional misbehaving (uM), let say the misbehaving covers the entire MANET i.e selfishness and attacks, iC* as inherent issues of MANET, *Im* as incentive mechanisms.

Considering Ad-hoc network environment consisting of N random placed nodes, where *nM* include *uM* and *iM*, here uM is caused by inherent issues, and *iM* caused by *uM* and nodes themselves (where iM is both selfish and malicious misbehaving). With the probability of randomly chosen nodes will misbehave $Q=nM/N$, predicting *uM* and *iM* are mutually exclusive

Therefore, $Q = Q_{uM} + Q_{iM} = nM/N + nM/N$ …………………………………………. (16)

Where Q_{uM}: is the probability of randomly chosen node is unintentional misbehaving.

Where Q_{iM}: is the probability of randomly chosen node is intentional misbehaving. As we eaid earlier it is the uM that set up iM, so we will be modeling using techniques to resolve iM.

Let h =miM/uM , is the ratio between intentional misbehaving and unintentional misbehaving

i.e. $0 \leq k \leq 1$, then $QuM = knM/N, QiM = (1-h)nM/N$…………………………….(17)

since QuM set up iM then

and *Im (incentive mechanisms)* have been used to resolved *iM (intentional misbehaving)*but can't be used to resolve *uM but with some TxRx techniques. Let TxRx techniques be* $TxRx_{T.}$

therefore,

$QuM = knM/N*iCi*TxRx$……………………………………………………………. (18)

TxRx which involve special cooperation, higher order modulation, relaying strategies and multiuser diversity QuM was improved and QiM was reduced. The TxRx tackles iCi, thereby lowering uM and in turn reduced iM for proper message relaying.

The Relay Channel Mode:

In the figure below depict multiple routes relay channel; we assume long distance L might sometimes not exist (especially in ad-hoc network) because *S* is not wirelessly in the range of *D* involving many nodes. So we model with using relay nodes with no direct link btw *S and D*, and in many occasion using relay nodes with higher coding schemes *DF and CF* make relay link better than direct *S* to D link, we adopt non-orthogonal as described below, considering memory-less channel. Modeling in half duplex relaying (time or freq), because full duplex in relay mode have designed challenges. In ad-hoc there routing protocols for route discovery and selection of the best routes to forward packets but with design in this paper i.e. with concept of relaying with receiver/transmitter cooperation, it implies that all routes will be best since relaying using multiple nodes do not consume energy and network resources as much. Since there are many relaying nodes involve, we will adopt 2 relay node, S is the source node, D is the destination node and R1 and R2b are the relaying nodes that cooperate with the source to transmit a frame length message M, we adopt the method used in (Vladimir Stankovic, 2006) with some additional modification. The multiple routes relay channel can be entirely illustrated by the channel allocation

$p(y2, y3, \ldots, yT \mid x1, x2, \ldots, xT-1)$ on $Y2 \times Y3 \times \cdots \times YT$, for each $(x1, x2, \ldots, xT-1) \in X1 \times X2 \times \cdots \times XT-1$, the

frame message length of M is divided into two parts: code message Ms1 and Ms2, since we use half duplex during transmission of the frame length message, owing to this half-duplex relay property, the maximal period of time the relay able to listen is given by α = ½, the relaying time divisions are

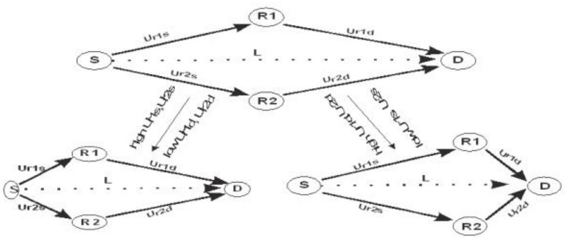

Fig. 5.0: Multiple routes relay channels.

Relay 1 receive time of length $m\alpha = \alpha$

Relay 2 receive time of length $m\beta = \beta$

Relay 1 transmit time of length $m(1-\alpha) = 1-\alpha$

Relay transmit time of length $m(1-\beta) = 1-\beta$

where the Ms_1 and *Ms2* are transmitted to *Rn1* and *Rn2* respectively at different time, at time mα Rn1 receives yr1 (Ms1) and process and decode using higher order modulation than the S and transmit a code word Mr1 = fr(yr) in m(1-α) time, during Rn1 Tx mode Rn2 simultaneously receives its code word Ms message, the idea is when Rn1 transmit Rn2 receives so Rn1 never hears the code word meant for Rn2. The Tx abd Rx are done using relaying coding scheme describe above. Then M encode into mα length code word Ms1(m) and mβ-length code word Ms2(m), therefore the receive signal at Rn1 and Rn2 during relay receive time are

yr1[n) = Er1sUr1sMs1(m)[n] + Ur1s[n]…………………………………………………………………….(iii)

yr2[n] = Er2sUr2sMs2(m)[n] + Ur2s[n]…………………………………………………………………….(iv)

where Ur1s and Ur2s are the independent distributed AWGN and Er1s and Er2s are the complex power constraints or average signal energy received over the channel.

Additionally, taking the advantage of non-orthogonal cooperation, where the transmitter of Rn1 and Rn2 are synchronize during transmission time i.e. Rn1 and Rn2 signal energies are transmitted to D at the same channel time, Rn2 can completely assume Rn1 will Tx Rn2 Transmission time, then Rn2 can also tx in the same signal at same time (both Relay Rn1 and Rn2 tx and forward in the same channel, therefore D receives same energy signal with a calibration phase shift or superposition signal from the two relays, the SNR energy receive at D is

RX = E [yr1[n] yr[n]] = E|yr1r2[n]|2 =

Er1s(|Udr2 + Uds)(Ms2)[n] – Er2(|Udr1 + Uds|)(Ms1)[n] + U[n]………………………………(v)

i.e. Ms1 and Ms2 at destination D add up coherently.

RBF TRUST METRICS (in form of trust and trustworthiness):

The RBF inform of positive, neutral and negative network activities performed can be map to high reputation R_H, mid-reputation R_M and low reputation R_L value rating respectively, but before the computing with trust values and reasoning about propagation and aggregation are done, there the needs to agree on a trust model, so that the interpretation of a reputation trust value can be fixed. In Victor *et al*. [62] we conjured our approach to represent trust (that the node will help others) and distrust (that a node might misbehave) as two distinct but dependent gradual concepts that are not opposites of each other. The model is based on the following theorem:

Theorem 1:

RBF is positive or or negative i.e. high or low reputation [2009a]. A RBF network couple (i, j) whereby i is the set of nodes and j is an $A \times A \rightarrow [z,y]^2$ mapping that associates with each couple elements (x,y) of users in i, a RBF score rating of j(x,y) = (t,d) in $[z,y]^2$,in which t is called the RBF R_H degree (trust) rating and d the RBF R_L (distrust) degree rating .

Theorem 2:

This is the direct and indirect observation of the nodes base on opinion and knowledge of network activities carried out i.e. RBF knowledge Ordering. [2009a].

The RBF (R_H, R_M and R_L) ≤ td and opinion and knowledge ordering are defined by

$(t_1,d_1) \leq td\ (t_2,d_2)$ *iff* $t_1 \leq t_2$ *and* $d_1 \geq d_2$

$(t_1,d_1) \leq k\ (t2,d2)$ *iff* $t_1 \leq t_2 andd1 \leq d_2$

for all $(t_1,d_1) and (t_2,d_2)$ *in* $[0,1]^2$

Opinion and knowledge ordering of network activities P performed by nodes for each other in the network are mapped into RBF inform of trust R_H and distrust R_L. In other words, a RBF score represents both the trust (fulfilling positive objectives of being in a network) and distrust (fulfilling negative objectives of being in a network shown in table 3) relation between two paired agents. Bilattice theory [2009] enables us to compare the trust scores inform of RBF rating values in several ways. The lattice $([z,y]^2, \leq td)$ orders the RBF scores going from complete RBF R_L (z,y) to complete RBF R_H (y,z). The lattice $([z,y]^2, \leq k)$ evaluates the amount of available RBF R_H evidence, ranging from a "shortage of evidence", namely, t1+d1 <y, to an "excess of evidence", namely t1+d1>y; the valuet1+d1is also called the knowledge degree of the RBF R_H score (t1,d1). The boundary values of the≤k ordering, (z,z) and (1,1), reflect ignorance, respectively, contradiction. So the RBF scores rating can be use to compare the degree of RBF RH and RL sores rating a user may have in other users in the network, or to compare the uncertainty that is contained in the trust scores.

Distributed Cooperative Diversity Techniques (DCDT):

We denote the combined diversity techniques we employed here as DCDT, because nodes are distributed, decentralized and random in nature. DCDT comprise of several diversity techniques that we employed into proposing the protocols in this paper in order to improve the relaying environment of the network we considered.

Our MAC Protocol Designs (DCDT MAC protocol):

We propose a **DCDT MAC** protocol that uses spatial diversity (antenna diversity), relaying strategies with higher order modulation and multi-users diversity. The space diversity uses directly situated single-antenna network use nodes that cooperatively send or receive by forming arrays of virtual antenna, i.e. combination of relay nodes to transmit copies of the data packet from the source to destination node. The relays use different relaying strategies DF/CF process, in this work we used two most important relaying strategies base on the proximity of the relay nodes to the source and the destination nodes as seen in Figure 34 multiple routes relay channel.

DCDT MAC is design as a diversified MAC protocol utilizing available multi-routes from the multi-users channel. As it is known that incentive node coop scheme are designed according to the original basic access scheme in 802.11, but the one in this work is according to cooperative basic access scheme where Multiuser diversities are utilized in routing.

THE Cooperation Channel set-up and Negotiation:

The figure below shows the protocol channel setup and negotiation in simple way whereby collision is being avoided among packets. From 802.11 basic access scheme (no relays, no node misbehaving just direct transmission which is not always possible due to long distance multi-hop channels). In the channel we use two channels: control channel made up of the handshake styles as control packet and the data packet channel as the user data. Here using coop relaying, automatically forwarding of received data packet is done by relay node whereby there is no waiting for DIFS such scenario makes ACK timeout to be created by the relay node. And since direct Tx is not feasible or fails then to ensure credible cooperative transmission through relay node, an ACK will be forwarded through a double step ACK designed in the scheme i.e. ACK message from D to R then to S nodes. If coop transmission fails which can't fail because we are using a selection of 2-3 relays routes with HQ, higher SNR (brought about by the inbuilt EDRP)?

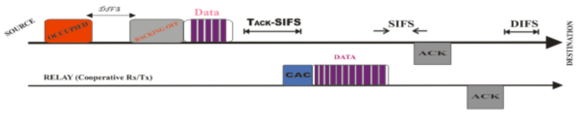

Fig. 6.0: Channel set-up and Negotiation.

The introduced cooperative assigner vector CAV control packet layup channels for cooperative transmission operations and information in the cooperative assigner vector packet can be used by other nodes to set their network assigner vector values. The contents of the CAV are the time length, period from the beginning of the relay packet forwarding to the end of the second ACK packet. The CAV and RTS have the same frame format. Base on basic data rate set the CAV frame is transmitted at a data rate for the purpose of securing the whole cooperation transmission packet exchange over a larger multi-hop as indicated in figure 3.2, with 2-3 relay node the whole transmitted information are well protected and cannot be interrupted by nodes.

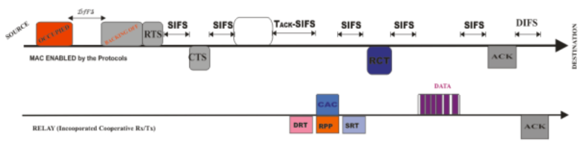

Fig. 7.0: Channel set-up and Negotiation with cooperative transmission.

In this scenario of cooperation transmission, hidden terminal problem might want to set in but the included control frame called *resolve relay channel to transmit (RCT)* is added to serve as in the DCDT-MAC cooperative RTS/RCT scheme. The duration in time consumed by cooperative transmission operations are the contents of cooperative assigner vector (CAV) and *resolve channel to transmit (RCT)* frames for laying up the channel between relays and destination nodes as the same format in 802.11 RTS and CTS frames and will be forwarded at the similar rate as the RTS and CTS frames respectively.

For cooperative transmission to be fully initiated these three handshake styles: Relay Prompt to transmit (RPP), Destination Resolve for relay to Transmit (DRT) and Source Resolve for relay to Transmit (SRT) are involved, these handshakes add more simplicity to the protocol *when nodes need to cooperate* and *whom to cooperate with* for repeat transmission at a time so that collision can be prevented when cooperating transmission is on. Below is the packet format of our protocol showing various control packet and user data packet.

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Description of Our System Incorporation (Protocol Overview):

In the system, we have two parts: RBF and the DCDT-MAC protocol with cooperation enforcer (basically for intentional misbehaving nodes), the DCDT-MAC protocol features the techniques in section 4 improve relaying of packets by combining nodes antennas inform of virtual MIMO i.e. forming multi path or routes (space diversity), after the network has used the request/reply of our modified efficient routing protocol DPR (AODV based) protocol to get the knowledge of the network using single and promiscuous pairing. The source S relay/send out multiples copies of the packet x: Ms_1, Ms_2 *and* Ms_n at different time intervals through transceiver coop routes using the inbuilt Noco-DCDT MAC to coordinate spatial Tx/Rx and relaying strategies among participating relay nodes, encouraging relay nodes in adverse affected wireless environment to send and receive since they will use very minimal energy of the network resources in order to counter unintentional misbehaving.

It uses coding schemes DF and CF depending on how close or far the source S, destination D are to the relaying nodes, and a higher order of modulation at the relay nodes than the source node. The described features improve the efficiency of the medium, address the unintentional misbehaving weakness of past and current IEEE 802.11based node cooperation enforcer. And finally Reputation Based Function RBF is added to handle the intentional misbehavior of nodes' attack, and uses RBF that exist bet single and promiscuous pairing nodes i.e. building reputation locally among nodes whereby each node maintains a set of records signifying the connections with other nodes.

Base on the RBF, when a node has a scheduled packet to be transmitted, it first confirm using promiscuous pairing whether these packets can be sent and which routes should be used, when an intermediate relay node on the selected routes receive a packet forwarding request, it will check whether it should forward the packet and through promiscuous pairing the S node that want to sent packet can use RBF rating properties stored in the table catching to know available best routes. Once a node has effectively relay a packet on behalf of another node, it will request a RBF rating for the work it has done from its single and pp neighbor.

The most important constraint of node not wanting to take part in routing being energy constraint as been improved or address by incorporation Noco-DCDT MAC protocol into node coop enforcer so that unintentional selfishness of some legitimate nodes will be solved. With a multi-hop network direct transmission from the S to D might not be possible so the relays r_1, r_2 and r_n are involve, with successful DF and CF done at different time slot β, **Ω** because of multiple transmission, there will be several copies of the data packet that will survive the adverse physical path, and the received copies of the signal can be combine using MRC base on the weighted SNR, resulting SNR yields $\sum_{k=1}^{N} SNR_k$ where SNR_k is SNR of the received signal k. The SNR for the efficient relaying channel coding is the sum of the r_1, r_2 *and* r_n are relay frames' SNRs which resulted into BER performances of PLCP and MPDU's for relaying strategies (DF/CF) as (1920)

$$P_{PLCP}^{DF/CF} = Q\left(\sqrt{20\left(\alpha S + \alpha r_1 + \alpha rn\right)}\right) \quad (17)$$

$$P_{MCDU}^{DF/CF} = 1 - \left(1 - 0.75Q\left(\sqrt{0.8\left(\alpha S + \alpha r_1 + \alpha r_2 + arn\right)}\right)\right)^2 \quad (18)$$

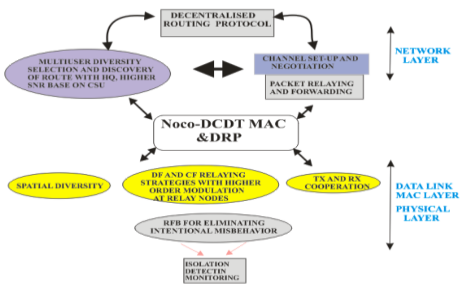

Fig. 8.0: The Protocols Framework.

Detailed Descriptive Example of the proposed Protocols:

We use this detailed descriptive example as shown in figure. 5.2 to show incorporated Noco-DCDT MAC protocols node cooperate enhancement scheme, how the protocols in general can improve transmission, relaying data packets, higher order relay enabled by eliminating unintentional misbehaving that always/must arise in MANETs due to its nature (inherent characteristic issues), and how intentional misbehaving nodes can be enforced and stimulated to cooperate.

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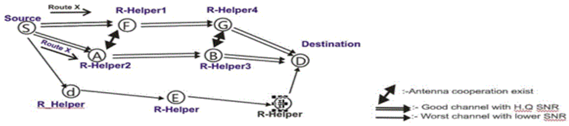

Fig. 9.0: Descriptive Example incorporating the proposed protocols.

Suppose that a source node K wants to send a message containing (500 data packets) to a destination node T, with the incorporated protocols, channel setup and negotiation, multi-routes with high quality (HQ), high SNR are discovered by handshake styles mechanism, i.e. node K with the help of inbuilt protocol able to discover the shortest multi route channels to node T through:

Route X hops 1 and 4 (best Channel State Info)
Route Y hops 2 and 3(moderate CSI)
Route Z hops 5, 6 and 7(worst CSI)

By channel sensing that exist base on single and promiscuous pairing between node, with the inbuilt protocol it can be known that route Y and X are of high quality (HQ), high SNR.

Note: what if it is not a multi channel access protocol, how successful will the relaying of these transmissions be, we then formulate some condition that our protocol are able to address, the followings:

- *how can these node F and G (Route X hops 1 and 4) able to send the whole 500 packets,*
- *what is the amount of delay it will take node F to send 500 packets*
- *the probability that node F will drop the packet,*
- *Can its energy be sufficient enough?*
- *If the channel suffers degradation i.e. deep fade all packet will dropped*

Then with above conditions coming up with: why not the need of node coopration enhancement scheme possessing nodes combination in relaying the packets not only node F and G, so that level of misbehaving can be reduced or eliminated.

Base on our concepts, single and promiscuous pairing among nodes A, B, C, D, F, G and I for the purpose of building and knowing each other RBF rating in form of rendered and received help will make every nodes to participate in cooperation relaying in order to build valid and essential reputation since our protocol aims in the network involves several number of multichannel nodes not only one node combine little resource and energy to relay packets, this definitely makes node to be willing to cooperate. Through the incorporated protocols, 500 packets is divided into 3 parts = 200, 200 and 100 packets i.e. every multi routes X, Y and Z Transmit divided packets with less energy, with cooperative techniques strategies applied at relay nodes. The update procedure of the protocol needs to handle two cases, namely, unintentional misbehaving which is settled by the above description and intentional misbehaving either one of the A, B, C, D, F, G and I will cooperate by forwarding the packet or misbehave by refusing to forward the packet even at less energy used i.e., drops the packet, but with built in parameters of the network nodes are at ease to participate in routing since much of their transmitting resources are less used, according to this fact we show how the protocol works, as follows:

Multi relay routes (MRR), spatial cooperation, higher order modulation at relay node, power control and the built in routing protocol are enabled in order to do multi access channel relaying of more packets with a minimal energy, i.e. out of 3 MRR at least 2 MRR (*Route X hops, 1 and 4, Route Y hops 1 and 3*) are sure to forward without dropping packets. As it is known that one of the important purposes of node cooperation enhancement scheme is to eliminate node misbehaving by encouraging cooperation, so with incorporated DCDT MAC protocol we believed that these misbehaving can be eliminated and if not the added RBF incentives can also be used to eliminate it. With these techniques incorporated ICI that causes unintentional misbehaving can be eliminated, thereby eliminating intentional misbehaving (selfishness and maliciousness).

Performance benefits Noco-DCDTMAC protocol in relaying channel in a MANETs ICI environment:

1. The destination node can combine the received signal from all forwarding relay nodes by using the receives copies of same energy signal with a calibration phase shift or superposition signal from the two relays, then add up coherently maximum ratio combiner MRC.

2. Different relaying coding strategies: DF and CF are use for coding and decoding at the relay nodes, which is like using error-correcting codes in cellular network

3. The relay can use soft information like CF by using soft decision in decoding error correcting codes

4. Two three relays are allowed to transmit simultaneously at moderate SNR to increase transmission rate

5. Space time coding:- Virtual MIMO uses same gain as MIMO systems when relay use coherence method to combine signal constructively.

6. Use of multiuser diversity to select and discover the high quality, high SNR routes or paths.

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Simulation and Performance Evaluations:

We have implemented a discrete event simulator NS2 (VINT Group,) to evaluate the performance evaluation of our protocols.. We did some modification to PHY and MAC layer parameters for the purpose of simulating 802.11g standard specification (http://standards.ieee.org/about/get/802/802.11.html) and for all these factors to be bonded in an achievable throughput base on the proposed protocols. The following modules: the fading channel, path loss, interference, noise and the physical error model have been considered in order to reduce their important effects in simulation results. Each source node generates and transmits constant-bit rate (CBR) traffics.

Simulation Parameters:

We assume that the same channel bandwidth for each protocol: 1.5 Mbps, uniform error bit rate with 0.05 to get a reasonable simulation with a data packet payload length set to 800 bytes at an interval 0.015, RTS and CTS sizes frames are automatically set to 37, and 31 bytes respectively, and the ACK data packet size is set to 31

Table 1.0: A summary of the features of the protocols evaluated.

Protocol	Incentive Mechs (802.11)	*DCDT MAC*
Number and type of channels	*1*	*1 control and 3 data channel*
Number of transceivers	*1*	*1*
Uses Transmission power control	*Nil*	*Yes*
Evaluation	*NS2*	*NS2*
SIFS	*9us*	*20us*
DIFS	*16us*	*10us*

Table 2.0: Simulation parameters.

Simulation Configuration Parameters	*Value*
Frequency	*2:4 GHz*
Incentive Mechs *802.11 Basic channel rate* *Data Channel rate*	*35 Mbps* *1000 kps (5 x 1000 = 3Mbps)*
DCD MAC Basic channel rate *Data Channel rate*	*35 Mbps* *1000 kps (3 x 1000 = 3Mbps)*
Processing gain	*11 chips*
Frame types	*Byte size*
Transmission power	*20 dBm*
FCS (frame check sequence)	*32 bits*
RTS	*37BYTES*
CTS	*31bytes*
Max number of relays transmissions	*3 i.e. at-least 3 relay nodes*
ACK frame size (include headers)	*304 bits (around ACK 31bytes)*
MAC header	*192 bits*
CBR data packet Size	*800 bytes*
Time slot	*30µs*
Routing Protocol	*AODV*
Error Bit Rate	*0.05 at an interval 0.015*

We have carried out three simulations: incentive mechanisms IEEE 802.11 based, *Noco-DCDTMAC* protocols based on 802.11 standard specifications and level of node intentional and mostly unintentional misbehaving (node selfishness and maliciousness) showing how they are better reduced and eliminated other than the use of incentive procedures alone. The throughput, end to end delay, packet traffic delivery ratio, number of channel access simultaneously results of nodes cooperation are being analyzed.

Simulation Results and Analysis:

We have carried out three simulations, one for IEEE 802.11 without incorporating cooperative diversities, the one with the DCDT-MAC protocols based on 802.11 standard specifications. The third one showing how level of node misbehaving (node selfishness and maliciousness) are better reduced and eliminated owing to the use of incentive procedures alone.

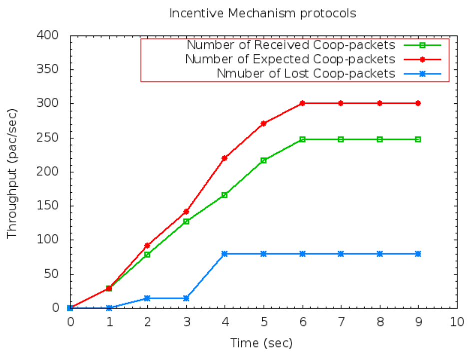

Fig. 10.1: Throughput: node incentive mechanisms node cooperation schemes.

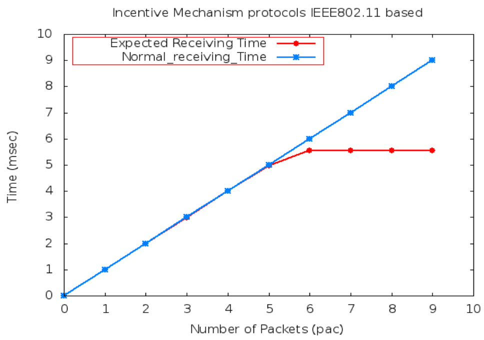

Fig. 10.2: (*end to end delay*) of incentive mechanisms node cooperation schemes.

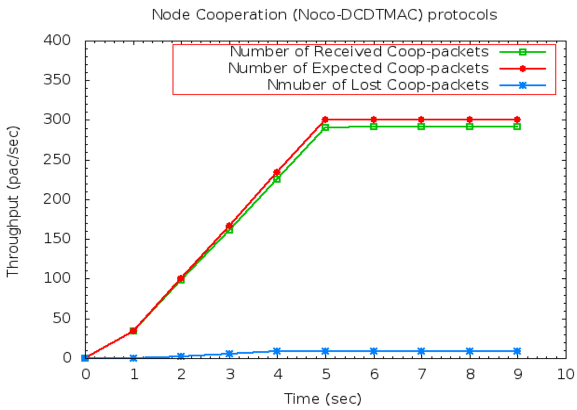

Fig. 10.3: Throughput: with No*co-DCDT MAC* protocols diversity techniques cooperative transmission.

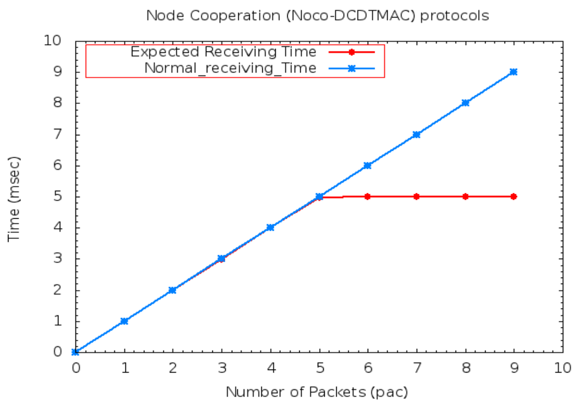

Fig. 10.4: Delay (*end to end delay*) with *Noco-DCDT MAC* protocols cooperative transmission.

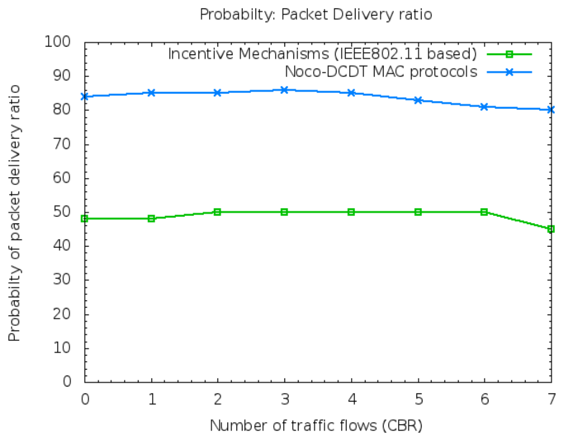

Fig. 10.5: Packet traffic delivery ratio of *Noco-DCDT MAC* Protocols cooperative transmission.

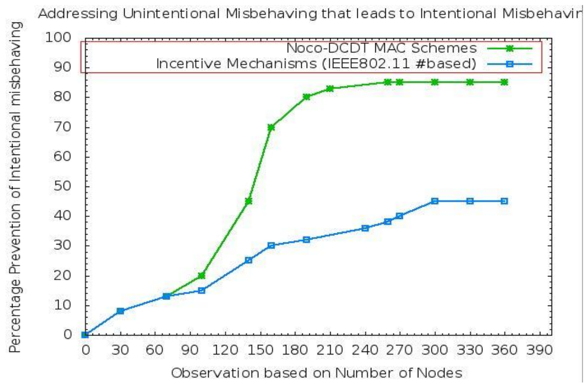

Fig.10.6: Percentage of Unintentional misbehaving addressed.

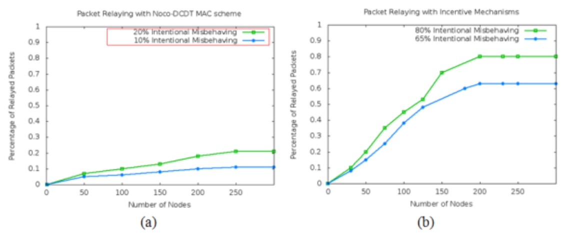

Fig. 10.7: Packet Relaying with both protocols with level of node misbehaving.

Figure 10.1 and 10.3 shows throughput analysis based on *number of coop-packets transmit and received*, *number of expected packets received* and *number of packets lost* during packets transmission from the source node to the destination node, figure 10.1 shows that number of packets received are less than number of expected packets to be received, meaning there are higher number of packet loss because there is no Tx/Rx diversity techniques transmission which implies that there are higher percentage loss in the number of packet transmitted from source node to destination due to node unintentional misbehaving (inherent issues) in the MANET. Figure 10.4 shows that numbers of packets received are almost the same as number of expected packets received, meaning that there are much more in number of packets transmitted, this because of Noco-DCDT MAC Rx/Tx incorporated. It implies there are less node misbehaving (unintentional misbehaving is reduced or eliminated), the incorporated diversity techniques into the relay node shows improvement in packets relaying when it come to using relaying to tackle the inherent characteristic issues of non-infrastructural network like MANETs.

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It can be deduced that in figure 10.3 and 10.5, equal number of (500 packets) packets are forwarded between expected and normal time between 1ms to 5ms i.e. both are less than 10ms in overall expected and actual receiving transmitting time, but comparing end to end delay with Noco-DCDT MAC it can be deduced that it take less time of 5ms (expected receiving transmitting time) for the 500-1000 packets to be relayed from the source to the destination node, while incentive mechanisms takes above 6ms for 500-800 packets. This means with the proposed protocols it takes lesser time to transmit which invariably means both intentional and mostly unintentional misbehaving being are resolved better. It shows that bandwidths are not being wasted.

Figure 10.5 shows the probability of packet traffic delivery ratio (PDR) analysis, with higher throughput and lesser delay of the proposed scheme, it can be seen that with repeat transmission i.e. with diversity techniques incorporated into Noco-DCDT MAC, it can be deduced that PDR was better to a reasonable level. We obtained 80% PDR (CBR and TCP), which implies intentional and mostly unintentional misbehaving was eliminated by resolving inherent characteristic issues.

Figure 10.6 shows the percentage of unintentional misbehaving being addressed by the proposed protocols. Due to the techniques incorporated into the node cooperation scheme ICI which is the major cause of unintentional misbehaving that leads to intentional misbehaving are greatly addressed. Figure 10.7 shows packet relaying with both protocols with level of node misbehaving, (a) the proposed protocols with Inherent issues ICI (unintentional misbehaving) addressed, level of intentional misbehaving were 10-20% while that of Incentive mechanisms was 65-80% level of intentional misbehaving because ICI was not addressed.

Conclusion:

It is known that successful application of MANET cooperation among nodes is very vital because most of the network activities need it. This paper, proposed a complete system framework for employing various diversity techniques (usually cooperative transmission) into a node cooperation enhancement scheme of wireless ad-hoc networks other than using incentive mechanism alone to enforce and stimulate to node cooperate. In node cooperation scheme we discover there are inherent issues of MANET that inherently set in unintentional misbehaving which then set in intentional misbehaving which incentive mechanisms try to solve by enforcing cooperation through incentive procedures. We in this paper provide solution to these unintentional misbehaving, by proposing Noco-DCDT MAC at the link layer, the network layer for efficiency in data packet relaying. Simulation result shows that our protocols consistently achieve better performance than incentive mechanisms. And also show how the levels of inherent characteristic issues which is the major cause unintentional which result to node intentional misbehaving (selfish and malicious) were reduced, eliminated

We in future plan to further improve the diversity techniques (cooperative system design) used by deciding to employ one by one the diversity techniques cooperative relaying e.g. higher order modulation at each hop. We will also study the overhead of our protocol.

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