CORA: A Technique to control Packet Loss in Multicasting AdHoc Networks

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Abstract--Ad Hoc network changes the location and configures itself. Cooperative Communication leverages the broadcast nature of the wireless channels and achieves the improvement in system capacity and delay. To manage the medium access interactions, an efficient Cooperative Medium Access Control (CMAC) protocol is used to improve the network performance in terms of lifetime and energy efficiency. By utility based relay selection strategy, performance is increased based on location information and residual energy. This strategy helps to select the best cooperative node with better channel condition, best relay and balanced energy consumption. However, the packet loss is not controlled. To overcome this, the proposed system using Collaborative Opportunistic Recovery Algorithm (CORA) which is designed for multicast applications with low packet loss and latency constraints. To recover peer-to-peer packet loss, Cached Packet Distance Vector (CPDV) protocol is used.

Keywords: Ad hoc Networks; Network Lifetime; Cooperative Communication (CC); Medium Access Control; Relay selection; Network Utility; Mulicasting

I. INTRODUCTION

Cooperative Communication (CC) has gained much interest recently as a new design paradigm to make terminals help each other in a distributed fashion. A Mobile Ad-hoc Network is a continuously self-configuring, infrastructure-less network of devices connected without wires. Cooperative Communication technique is used for conserving the energy consumption in MANETs. Distributed Energy adaptive Location-based Cooperative MAC protocols has been proposed which comprises the following such as a relay that is involved in a handshaking process, optimal power metric, a distributed effectiveness-based best relay selection strategy, and an innovative Network Allocation Vector (NAV) setting.

Cooperative Communication is a promising technique in Mobile Ad-hoc Networks. The broadcast nature of the wireless medium is exploited in cooperative fashion. The wireless transmission between a pair of terminals can be received and processed at other terminals for performance gain, rather than be considered as an interference traditionally. CC can provide gains in terms of the required transmitting power due to the spatial diversity achieved by use 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 an extra energy consumption.

The 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. A cross layer optimal transmitting power allocation scheme is designed which conserves the energy while maintaining certain throughput level. To deal with the presence of relay terminals and dynamic transmitting power an innovative NAV setting has been provided.

The paper proposes a recovery scheme that provides peer-to-peer recovery approach which communicates each member to recover the lost packets. With or without the wired infrastructure, it can establish an instant communication structure for civilian and military applications. Peer-to-Peer recovery tends to evenly distribute recovery overhead to the entire group instead of centralizing at certain nodes. A receiver attempts to recover lost packets with the aid of a random set of members in the group. Collaborative Opportunistic Recovery Algorithm (CORA) achieves the recovery which maximizes efficiency within latency. The contributions are: First, a localized peer-to-peer recovery strategy; Second, a deterministic Cached Packet Distance Vector(CPDV); Third, a tradeoff study between localized recovery benefits versus memory and processing overhead. It extends the collaboration of non-member nodes in order to locate local peers, allows a node to acquire one-hop neighbors caching status and/or CPDV entries with zero transmission overhead. It also reduces the communication overhead caused by recovery traffic and energy consumption.

The rest of this paper is structured as follows. Section II describes the related work of the proposed techniques. Section III illustrates the protocol design description. Simulation results and Performance Analysis are addressed in Section IV and finally the conclusion of this paper are presented in the section V.

II. RELATED WORK

The performance of Ad Hoc networks improved in terms of network lifetime and energy efficiency. To deal with the hidden terminal and the loss of packets , the paper (Xiaoyan Wang and Jie Li) solve the issues by applying the Distributed Energy-adaptive Location based CMAC (DEL-CMAC) protocol takes the energy consumption into account, which incorporates the distributed utility-based relay selection. An innovative Network Allocation Vector (NAV) setting is provided with the source and relay terminals. A best relay selection is based on location information and residual energy.

Therefore the protocol is implemented to solve all these issues mentioned in the paper.

Optimal Energy Efficient Multicast (OEEM) Algorithm is used to power capacities of intermediate node are checked with a threshold value and the distance. The paper (Lakshmi Kala Pampana and Srija Kathi) focused on power consumption (ie.,) every node in an Ad-hoc network must be able to function as a router which can forward the data packets to other nodes. Traffic Jamming is a main problem in Ad-hoc Networks. The distance is checked by two steps : Route discovery phase and Calculating the power and distance. This approach reduces the power consumption as well as selection of optimal paths for packet transmission.

The author (Krishna K.Pandey, Nitesh Baghel and Sitesh K Sinha) addresses the topology control problem for energy-efficient with Cooperative Communication (CC). An Ad-hoc Networks have various civilian and military applications, one of the major concerns in designing the wireless networks is to reduce the energy consumption. The transmission power of each node as to maintain network connectivity and consume the minimum transmission power. Each node is able to maintain its connection with multiple nodes by one hop or multi-hop, doesnot use its maximum transmission power. The main issue of this paper indicates that every node store power level of every neighbor node in routing table with routing information (Storage Overhead) and it reduces the overall power consumption.

Link failure occurs because of fading in the channel; here the channel's fading and non-fading duration is found. The average fading duration is the period of time the channel spends below the network specific threshold value. The average non-fading duration is the period of time the channel spends above the network specific threshold value. The paper (A.Ayyasamy and K. Venkatachapathy) proposed a new Load Based Channel Aware-Ad hoc On-demand Multipath Distance Vector (LBCA-AOMDV) protocol for load balancing in the network, the performance is compared by increasing the number of nodes and changing the size of the network. The overloaded process is completed and then comes to the current running path, reducing the packet loss on routing.

Network Coding Supported-Cooperative Communication (NCS-CC) takes the coding opportunity, throughput and delay into account and is performed in a distributed and energy efficient with the minimum utility value. Pure-Cooperative Communication (P-CC) is employed in which the packets queuing in the relay node cannot be served during the retransmission process. These two approaches of NCAC-MAC comprises a relay-involved cooperative retransmission process and a network coding aware utility-based best relay selection strategy proposed by the author (Xiaoyan Wang, Jie Li and Mohsen Guizani) to choose the best relay and improved the throughput and delay of the network.The paper (Vinay Kumar Pandey and Dr. Harvir Singh) presents a novel CMAC protocol to improve the performance of the network, an innovative network allocation setting is provided to deal with the varying transmitting power of the source and relay terminals. Higher diversity gain can be obtained by increasing the number of relay terminals. To avoid the interference and conserve the energy, delicate NAV setting is required. NAV limits the use of physical carrier sensing, thus conserves the energy consumption. CMAC chooses the best relay based on a utility-based backoff which depends on the required transmitting power and the residual energy of individual terminals, increased the network lifetime in the networks.

III. PROTOCOL DESIGN DESCRIPTION

The DEL-CMAC protocol to improve the performance of ad hoc networks. To handle with the relaying and dynamic transmitting power, besides the conventional control frames. It introduces two new control frames to facilitate the cooperation i.e., Eager-To-Help (ETH) and Interference Indicator (II).

Eager-To-Help (ETH)

The ETH frame is used for selecting the best relay in a distributed and lightweight manner, which is sent by the winning relay to inform the source and destination. The best relay is defined as the relay that has the maximum residual energy and requires the minimum transmitting power among the capable relay terminals.

Interference Indicator (II)

The II frame is utilized to reconfirm the interference range of allocated transmitting power at the winning relay, in order to enhance the spatial reuse. Among all the frames, transmitted by fixed power and the transmitting power for the Interference Indicator frame and data packet is dynamically allocated.

A. *Utility-based Routing*

The best relay selection efficiently affects the performance of the CMAC protocol significantly. A distributed energy-aware location based best relay selection strategy which is incorporated into the control frame exchanging period in DEL-CMAC has been proposed. Selecting the best relay terminal based on the utility-based backoff, which depends on residual energy of individual terminals. The existing relay selection schemes that incorporated into the CMAC protocols, largely depend on the instantaneous channel condition, based on the assumption that the channel condition is invariant during one transmit session.

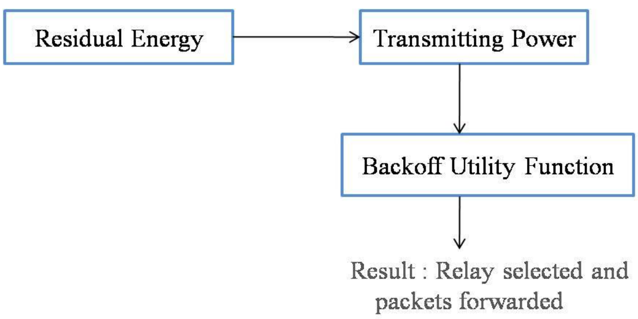

FIG.1: Utility Function

Backoff Utility Function

DEL-CMAC chooses the best relay based on a utility-based backoff, depends on the required transmitting power to meet certain outage probability and the residual energy of individual teminals. A utility function (BUr) is defined for relay r as follows:

$$BU_r = \tau \, min\left(\frac{E}{E_r}, \delta\right) x \left(\frac{P_r^C}{P_S^D/2}\right)$$

where E_r is the current residual energy of relay r. The transmitting power P_r^C at relay r in cooperative mode and P_S^D is the transmitting power at source s in direct mode. The parameter include the energy consumption threshold δ, the constant unit time τ, and the initial energy E.

$$E_r = InitialEnergy - EnergyConsumption$$

The terminal whose backoff expires first will be selected. The threshold δ is to restrict the maximum backoff time within an acceptable range.

$$EnergyConsumption = TransEnergy * SimTime$$

Using the relay selection strategy, the energy consumption rate among the terminals can be balanced, and the total energy consumption can be reduced.

B. Dynamic Power Allocation

The power consumption for each transmission needs to be determined. Addressing the power consumption for CC and direct transmission under the given outage probability. The transmitting power at source in the direct transmission mode, which is calculated by the destination after it receives the RTS.

Direct Transmission

The power consumption metric at source and relay in the cooperative transmission mode is calculated by individual relay terminals after RTS/CTS handshake. The minimum transmitting power in the direct transmission mode is calculated as follows

$$P_S^D = \frac{(2^R - 1)N_0 d_{sd}^{\propto}}{ln(1 - P_D^0)}$$

where R is the transmission rate , $d_{sd}^{\propto}$ is the distance between the source and the destination , $\propto$ is the path loss exponent and N_0 is the variance of the noise component.

Cooperative Transmission

The transmitting power at source P_s^C equals the transmitting power at relay P_r^C . A P_s^C is the solution as follows:

$$Ģ(d) = exp\left(\frac{-(2^{2R} - 1)N_0 d}{P_S^C}\right)$$

The cooperative transmission takes in order to which any relay terminal introduces the ETH frame to the source and the destination. The interference ranges in DEL-CMAC are changing during one transmit session. To avoid the interference and conserve the energy.

Spatial Reuse

The terminals on the wireless medium and set their NAV from accessing the medium. NAV limits the use of physical carrier sensing, conserves the energy consumption.

C. Router Recovery

Using the Backoff Utility function, the relay terminal is selected using the distributed energy adaptive location based cooperative MAC protocol. The packet loss is minimized by introducing a Collaborative Opportunistic Recovery Algorithm(CORA). The component of CORA is Cached Packet Distance Vector (CPDV) protocol is used to recover the missing packets.

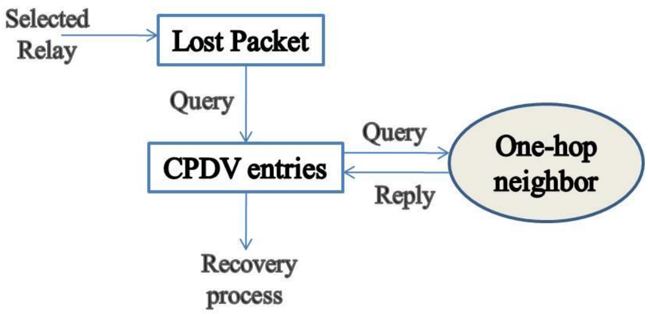

FIG.2 : Recovery Process

A member first tries to recover missing packets in its locality. CORA is designed to support multimedia applications and targets to maximize packet delivery ratio while sustaining bounded latency and minimizing recovery overhead. It trades off memory and processing cost for communication overhead by employing cooperative neighbor nodes keeping a short-term cache and/or CPDV table. It uses deterministic peer-to-peer recovery and attempts localized recovery to the greatest extent.

CPDV design choice minimizes the communication overhead caused by recovery traffic. It also reduces channel condition between recovery traffic and multicast traffic. The CPDV is a distance vector type, can locate the nearest copy of a lost packet and localizes the recovery process to the greatest extent.

IV. SIMULATION RESULTS AND PERFORMANCE EVALUATION

In our experiment, we used NS-3.21 simulator to analyze the result with a routing protocol DELCMAC-AODV with 20 nodes. We set the maximum size of a packet 400 and applied MAC protocol 802.11. The network channel areas were 5000m X 5000m. For simulation purpose, we initially set threshold point 100 and energy for each node as 200J. We analyzed the result with various network performance metrics. Some of the metrics are defined as follows, and the results are given in the following sub-sections.

A.Packet Delivery Ratio

The packet delivery ratio is the ratio of data packets delivered to the destination to those generated by the sources.

Mathematically , it can be defined as:

PDR = S1 / S2

where S1 is the sum of data packets received by the each destination and S2 is the sum of data packets generated by the each source. Figure shows that the packet delivery ratio increases with increasing time.

Table 1 Packet delivery ratio Vs Time

Simulation Time	PDR Values
100	0.449333
150	0.449635
200	0.450003

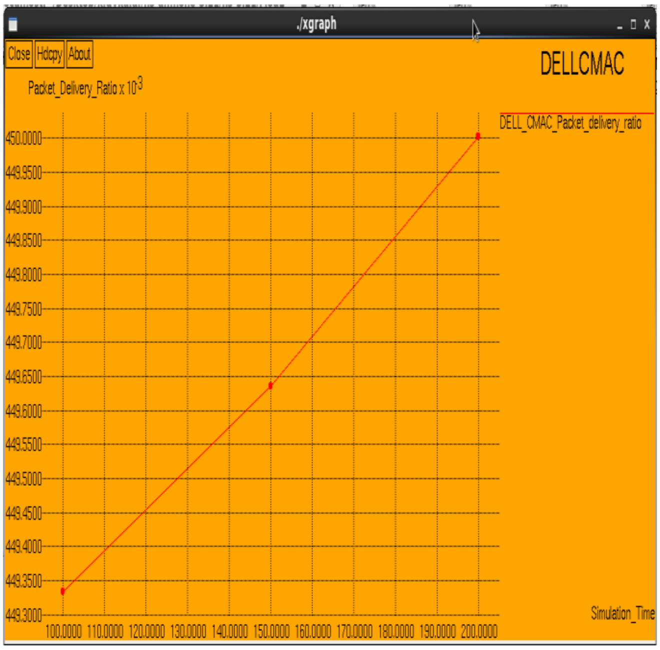

FIG.3 : PACKET DELIVERY RATIO

B.Throughput

It is defined as the total number of packets delivered over the total simulation time. Mathematically, it can be defined as:

Throughput= N / 1000

where N is the number of bits received successfully by all the destinations.

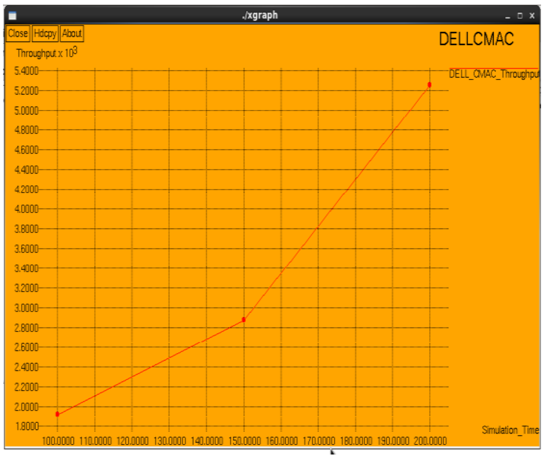

FIG.4 : THROUGHPUT

Table 2 Throughput Vs Time

Simulation Time	Throughput Values
100	1914.74
150	2872.07
200	5253.57

C. End to End Delay

The average time it takes a data packet to reach the destination. This includes all possible delays caused by buffering during route discovery latency. This metric is calculated by subtracting time at first data packet was transmitted by source from time at which first data packet arrived to destination.

Mathematically, it can be defined as:

Avg EED = S / N

where S is the sum of the time spent to deliver packets for each destination and N is the number of packets received by all the destination nodes.

Table 3 Delay Vs Time

Simulation Time	EED Values
100	359548
150	359988
200	360792

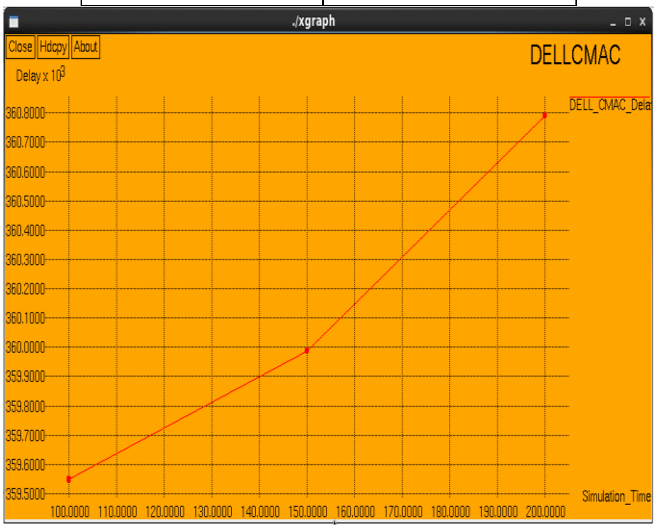

FIG.5 : END TO END DELAY

D. Energy Consumption Vs Residual Energy

Energy consumption is defined as amount of energy consumed in a system. This metric is calculated by multiplying the transmitted energy and simulation time.

Mathematically, it can be defined as:

EC = Trans_energy * Sim_time

Residual Energy is defined as the remaining energy of each nodes in the networks. It is calculated by subtracting energy consumption from initial energy.

Mathematically, it can be defined as:

RE = Initial Energy - Energy Consumption

Table 4 EC and RE Vs Time

Simulation Time	EC Values	RE Values
100	63.4933	106.507
150	63.4917	106.508
200	128.261	71.7391

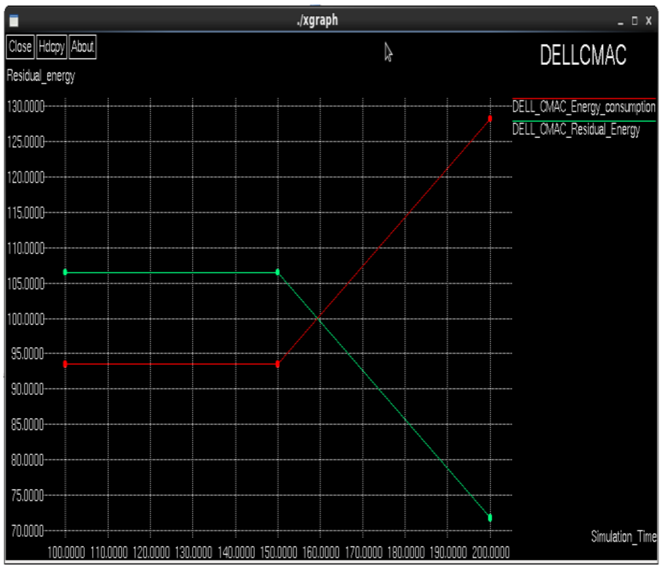

FIG.6: ENERGY CONSUMPTION VS RESIDUAL ENERGY

V. CONCLUSION

In this paper, the cross layer Distributed Energy adaptive Location based Cooperative MAC protocol for Ad-hoc networks has been demonstrated and choose the best relay terminal and the transmitting power in conserving the energy to prolongs the lifetime of network. Though DEL-CMAC have high packet loss and energy consumption. To overcome this, proposed recovery algorithm attempts to minimize the packet loss rate by CPDV routing, with bounds on latency. The local recovery of CORA recovers from random type packet losses due to channel error.

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