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A Hybrid Reliable Data Transmission based on Ant-agent Resource Allocation Technique in EEMCC Protocol for MANETS

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Abstract
Real time multicast applications in mobile adhoc network brings forward added advantages in wireless network. The fragile and mobile environment of adhoc network produces the need of bandwidth allocation for real time applications. Reliability is also an important factor in multicasting in mobile adhoc networks (MANETs), as it confirms eventual delivery of all the data to all the group members, without enforcing any particular delivery order in EEMCCP. In the first phase of this paper, we design an ‘ant agent-resource allocation’ technique for reserving bandwidth for real-time multicast applications. In the forward phase, the source sends a forward ant agent which collects the bandwidth information of intermediate nodes and reserves a bandwidth for real-time flow for each multicast receiver. In the backward phase, the backward ant confirms the allocation and feeds the bandwidth information to the source. Normal traffic flows can utilize this bandwidth temporarily until the real-time traffic starts. When the real-time traffic flow has to be transmitted, the temporary resource which is utilized by other traffic flows gets dropped and the real-time flow starts In the second phase of this paper, we provide a hybrid reliable data transmission technique for multicasting in MANET. It uses the advantages of both Automatic Retransmission Request (ARQ) and Forward Error Correction (FEC) approaches in a controlled manner to provide a lossless non real time data to the receiver. Our technique has two stages, where in the initial stage we differentiate the data traffic as real time traffic and non-real time traffic. For both type of traffics, data is transmitted using the ARQ technique initially. In the second stage, if the traffic is non-real time, it estimates the total data loss occurred at the receivers for a given time period. If the loss is greater than a threshold value, it transmits data using FEC technique until the loss becomes less than the threshold. In addition to this, the ant agents can be used to detect the QoS change, congestion and route breakage and also controls the reliability in a network.

I. INTRODUCTION

The main features of the ad hoc network are their speedy deployment and effortless reconfiguration, which makes them ideal in situations where installing an infrastructure is too expensive or too vulnerable.[21] MANETs have applicability in several areas like Soldiers transferring information for mission critical situation on the battlefield, information sharing by business associates at a meeting; people using laptop computers or other technical gadgets taking part in an interactive conference, emergency disaster relief personnel needs active networks during emergency situations, personal area and home networking, location-based services, sensor networks and so on .[20]

Multicast in MANET is a competent way for handling one-to-many and many to many communications. Multicasting is projected for the use of group based computing, where the relationship of a host group is typically dynamic and vibrant that is, hosts may connect and disconnect groups at will. There is no limitation on the location or number of members in a host group. A host may be a member of more than one group at a time. At the same time, a host may or may not have to be a member of a group to propel packets to the members in the group. The use of multicasting in MANET showers in the advantage of flexibility but also bring forth the challenges like suitable use of nominal bandwidth and reliability. Thus the effective use of bandwidth allocation in MANET Multicasting is considered as an important factor. The importance of bandwidth allocation increases with the use multimedia application. Multimedia applications like audio/video conferences which are Real-time applications need much more bandwidth allocation than Best- effort application like Email and File Transfer Protocol (FTP). As the case of all wireless environments, radio links are not complete foolproof and they are affected by several sources of errors and interference resulting in a high and variable bit error rate. Consequently, one of the critical issues of a MANET is its radio interface. The second one is the mobility of the nodes. Even then many existing and forthcoming applications in MANETs require the association of groups of mobile users. [20]

II. RELATED WORKS

Saida Ziane and Abdelhamid Mellouk [1] have proposed swarm intelligence based routing algorithm which are used to improve the resource allocation of multimedia traffic in MANET. The approach uses the multi path selection along with the swarm intelligence techniques to enhance the quality of service (QoS) for multimedia traffic over the MANET. The three types of ant agents in the swarm technique (regular forward ants, uniform forward ants and backward ants) use the information to identify the appropriate neighbors. Multiple paths are used, along appropriate neighbors, to improve the QoS instead of single path routing.

Ya-Ju Yu et.al [2] has proposed a utility-oriented (UO) resource allocation algorithm to exploit the system usage in which the usage is considered as the user's satisfaction. Here, optimization of radio resource allocation for Layer-encoded multimedia multicasting (LMM) over the wireless relay networks (WRN**)** are discussed and obtained an algorithm which tries to derive sets of LMM trees. The algorithm is a dual phase system, in which, one used to calculate the path using modified Dijkstra's algorithm. The other is a dynamic resource allocation phase using an incentive based technique to allocate maximized system utility.

De-Nian Yang and Ming-Syan Chen [3] have proposed a mechanism for the reduction of total bandwidth cost of the IP multicast tree by suitably selecting the cell and the wireless technology for every mobile host. The scheme is based on an algorithm of Lagrangean relaxation and introduces a distributed protocol which is based on the modified algorithm the modified algorithm produces the advantage of using dynamic group membership and mobility of members, no modification on the current IP multicast routing protocols. The algorithm provides reduction in total bandwidth cost of the shortest path tree as it searches the somewhat inferior solutions to evade trapping in locally optimal solutions.

A. Sabari and K. Duraiswamy [4] address the problem of traffic engineering multicast which optimizes many objectives like distance, delay and bandwidth concurrently. Here an Ant Based Multicast Routing (AMR) algorithm for multicast routing in mobile ad hoc networks has been introduced to resolve the Traffic Engineering Multicast problem. In addition to the existing factors, the algorithm estimates an additional factor in the costs metric that is calculated as the product of average-delay and the maximum depth of the multicast tree. Thus tries to minimize this combined cost metric.

Juan Liu et.al [5] have address the User Grouping and Bandwidth Allocation (UGBA) strategy in wireless multicast systems. The UGBA is used when there is a need of fixed bandwidth becomes at most important and at the same time the users are distributed uniformly. Here the two factors, fixed bandwidth allocation and the data transmission rates, are considered to provide a guideline to scheduling transmissions in wireless multicast systems. The problem of UGBA is handled by using a Signomial Programming (SGP) method which finds the suboptimal solution to any non-convex problem.

Loc Bui et.al. [6] have addressed the concept of shadow queues and proposed a shadow algorithm which tries to achieve the optimal solution for multi-rate multicast. Here the author introduces the techniques of 'shadow traffic' which are generated by the receivers and 'moving back' to the sources, and the corresponding 'shadow' (token) queues. The transmission of shadow traffic in the reverse direction then estimates the real traffic generation (at the sources) and its transmission through the network. In the network, setting up of the shadow traffic is initiated by the back-pressure-type algorithm nevertheless; the algorithm used is a non-standard back-pressure algorithm.

Kumar Manoj et.al [7] have proposed an algorithm, bandwidth control management (BWCM) model, to estimate bandwidth calculation and slot reservation for multimedia ad hoc wireless network The algorithm consists a group of mechanisms which are; control management used to calculates the bandwidth, co-ordination that arranges the allocation of the bandwidth, temporary resource reservation used to release the connection link or bandwidth after the completion of the communication. The model tries to improve the QoS performance in multicast communication and tackle its challenges like,unstable node topology and frequent failures, by minimized end-to-end delay.

In our previous paper [8], we have proposed an energy efficient and reliable congestion control

(EERCCP) protocol for multicasting in mobile adhoc networks. Our algorithm tries to overcome the disadvantages of existing multicast congestion control protocols which depend on individual receivers to detect congestion and tries to adjust their receiving rates. Our protocol consists of three phases;

Emy E. Egbogah et.al. [9] have proposed a reliable routing protocol named Scalable Team Oriented Reliable Multicast (STORM). STORM combines individual nodes with comparable mobility patterns and speeds into teams, and builds hierarchy-based multicasts mesh structure among elected team nodes. A Unicast Acknowledgement Scheme (UAS) is developed to construct the routing structure in an efficient manner. To improve the reliability of STORM, a modified version of Reliable Adaptive Congestion controlled multicasT (ReACT) is used as a reliable transport protocol. It offers scalability as the network size, multicast groups and total number of multicast group member's increase as well as creating and propagating control packets with reliable delivery and low memory consumption.

Bo Rong et.al. [10] have proposed a new hybrid error control scheme that combines interleaving, forward error correction (FEC), and threshold based ARQ to mitigate the error and loss effects encountered in MANETs. In particular, the threshold based ARQ is studied to shorten the transmission delay in reliable multicast. In order to work compatibly with a verity of MANET multicast routing protocols, this new scheme is based on Client/Server architecture which resides on the top of UDP layer. Moreover, they used specification and description language (SDL) to formally portray the hybrid error control scheme from a broad overview down to detailed design levels.

Mehdi EffatParvar et.al.[11] have proposed a reliable multicast algorithm with local recovery approach. By using the proposed algorithm, nodes can join to multicast group in minimum time and data delivery can be increased. The algorithm tries to accomplish fast recovery during any route breakage, so that the destination can connect to source in new route or in the same route.

Dimitrios Koutsonikolas and Y. Charlie Hu [12] have examined FEC's efficiency in wireless network by implementing four reliable schemes initially proposed for wired networks on top of On Demand Multicast Routing Protocol (ODMRP). They proved that pure FEC can offer significant improvements in terms of reliability, increasing Packet Delivery Ratio up to 100% in many cases, but it can be very inefficient regarding the number of redundant packets it transmits. Moreover, a carefully designed hybrid protocol, such as RMDP, can maintain higher reliability while improving the efficiency compared to a pure FEC scheme.

Erik M. Ferragut [13] has proposed a new erasure code as a solution to the dynamic erasure code problem. The dynamic erasure code problem is to extend the digital fountains concept to a message generator, simultaneously with the transmission (i.e., live data). Solution of this problem provides a means for robust multicasting or one-way transmission of live data on a computer network. It also gives a method for robust distributed storage of log data, or other serially generated data.

Ali Alsaih and Tariq Alahdal [14] have proposed a reliable multicast transport protocol over combined networks using sub sub-casting called RMSS. It is based on a hierarchal structure where receivers are grouped into local regions. In each local region there are special receivers, which are called designated receivers and mobile agents. Each of the receivers is responsible for retransmission of requested packets to the receivers which are in their local region. Here a sub sub-casting is used to retransmit the data only to the requested receivers.

In our previous paper [14], we have proposed an energy efficient and reliable congestion control (EERCCP) protocol for multicasting in mobile adhoc networks. Our algorithm tries to overcome the disadvantages of existing multicast congestion control protocols which depend on individual receivers to detect congestion and tries to adjust their receiving rates. Our protocol consists of three phases;

First phase - Builds a multicast tree routed at the source, by including the nodes with higher residual energy towards the receivers.

Second phase- An admission control scheme, depending on the output queue size, to analyze flow is admission or rejection

Third phase- Adjusts the multicast traffic rate at each bottleneck of a multicast tree.

III. PROPOSED SCHEME

A. Ant Agent-Reservation

In this paper, we use an 'ant agent-reservation' technique for reserving bandwidth for real-time application when a new multicast receiver is joined. Our technique has two phases; forward phase and backward phase. In the forward phase, the source sends a Forward Ant Agent (FAA) which collects the bandwidth information of intermediate nodes. In the backward phase, the Backward Ant Agent (BAA) confirms the allocation and feeds the bandwidth information to the source along with reserving a bandwidth for real-time flow for each backward nodes. Before we discuss about the two phases, we analyze how the ant agents work.

B. *Ant agents*

Ant agents are generated at the source and are probabilistically being sent to the destination passing through the intermediate nodes. Each node in this network possesses two tables; a private table (PRT) and a public table (PUT) [22]. The PUT provides each FAA to choose its next hop. In PUT pheromone values of neighboring nodes are stored. These values decide the ant agent to select the next node. The probability value Pij to choose the best neighboring node j from a source node i is given by;

$$Pij = \frac{[Tpj]^x[Rj]^y}{\sum_{l \in N}[Tpl]^x[Rl]^y} \tag{1}$$

The probability value to choose the best neighbors among N nodes is done by using pheromone trail value Tp and a Trail-and-error method Rj. X and Y are particular weight value for Tp (optimal value for X and Y are 1 and 2 respectively). The Rj values are calculated by taking the network interface Queue length (Qj) along the outgoing link. The value of Qj is carried on using traffic state and a quantitative measure associated with the queue waiting time. Thus the value of Rj is obtained as;

$$\text{Rj} = 1 - \frac{Qj}{\sum_{l \in N} Ql} \tag{2}$$

The private table (PRT) contains the average time and variance values along with the bandwidth information of the node for each destination to which the forward ant has been previously sent. The average time and variance values from PRT are used to calculate the pheromone value. The pheromone value is updated regularly using an incentive based scheme in which every node which successfully transmits the ant agent is awarded an incentive, whereas the other nodes are not updated. This helps in finding the best node, as higher the value, provides higher strengthen link. The pheromone values are calculated as stated below;

$$PH=PH+ Inc \tag{3}$$

Where, PH is the weight value of the pheromone,
Inc is the increment value. The increment value is calculated by the trip time Tt and average trip time μ. The value of s, which is the scaling factor, is usually kept as 2. The value is given by;

$$Inc = \frac{Tt}{s\mu} \quad \text{if } \frac{Tt}{s\mu} < 1 \text{, where s > 1}$$
$$= \quad 1, \qquad \text{otherwise} \tag{4}$$

The value of PUT determines the neighbor nodes and contains the public values to determine the next hope. The values of PRT are the private values between a particular source and receivers.

C. Forwarding Phase

In the previous section 3.1.1, we discuss the ant agent moving from source to destination. Here we determine the bandwidth estimation using FAA to calculate the available bandwidth of each node along the path. The FAA contains a BW_INFO packet which carries the bandwidth information. It has source IP address (SA), destination IP address (DA), message type (MT), flow ID and requested data rate field (RDR).

SA	DA	MT	FLOW ID	RDR

Fig. 1 BW_INFO packet

The SA and DA consist of the source and destination ID's respectively, MT denotes the message type which has to be sent in the flow and flow ID denotes the flow type to be transmitted. RDR is the field where the requested bandwidth information is stored. During the forwarding phase in each hop, the FAA checks the available bandwidth (given by eq.5) of the node with the value stored in the RDR field. If the values are equal or more than the RDR value, the next hop is attained without any modification in the field. In the same case, if the available bandwidth is less than the threshold value, the node modifies the RDR value with the available bandwidth in the node.

3.1.3 Backward Phase

After reaching the destination, the FAA is modified as Backward Ant Agent (BAA) by transferring all its fields and is sent back to the destination along the same trailing path. During the backward phase, the BAA revisits the nodes and checks for the available bandwidth again. If the node has available bandwidth (eq 5) less than the RDR values, the RDR values are modified to lesser values. If the value is greater than the RDR field value, bandwidth reservation is carried on. To determine the congestion and link activity as well as to avoid improper admission, we use the PRT values. The BAA provides this information to source node by the BW_INFO packet. The values obtained in the RDR field determine the threshold value for the bandwidth to transmit data (Data Rate). Thus for all real time traffic, a threshold bandwidth value is determined for transmission.

3.1.4 Transmitting Real-Time Traffic

In MANET, the link capacity is fragile due to node mobility and other time varying situations. The available bandwidth is determined by the total rate value assigned to the link (TR) and the link capacity (LC) value. We can determine TR values by measuring the traffic values taken from PRT and the

LC value is determined by calculating throughput value TH of a single packet transmission [17].

$$TH = \frac{S}{HT} \quad (5)$$

Where, S is the packet size and HT is the halt time of each packet which is the difference between time at which ACK is received (Tack) and time for a packet transmitted (Ttran). Thus is HT is given by,

$$HT=Tack-Ttran \quad (6).$$

The available bandwidth is compared with RDR value to determine the threshold bandwidth to be allocated. With respect to TR and LC, we can determine the available bandwidth (ABW) by;

$$ABW=LC+TR \quad (7)$$

The BAA value holds the threshold bandwidth value which is reserved for the Real-time flows. Normal traffic flows can utilize this bandwidth temporarily until the real-time traffic starts. When the real-time traffic flow has to be transmitted, the temporary resource which is utilized by other traffic flows gets dropped and the real-time flow starts.

Our scheme also checks for QoS changes, congestion as well as route breakages. We take into account the three scenarios;

Scenario 1: QoS changes

Our scheme calculates the available bandwidth (ABW) and feeds the information through BW_INFO packet. On Periodical updating of ABW, if it decreases below to a minimum threshold level, it indicates insufficient capacity of that node. The ant agents send notification to the source to either change the traffic through another path or waits for the path to be restored. This helps in maintaining a better Quality of Service (QoS) through out the network.

Scenario 2**:** Congestion Control

The ant agents determine the queue length in each node during the periodical visits. If the queue length exceeds its maximum value, then it indicates congestion. This information is passed on to the source by the agents and apparently the source reduces the rate to avoid congestion.

Scenario 3**:** Route Breakage

The ant agents are periodically sent to analyze the ABW value throughout the network. If the ant agents do not reach the source in the allotted time period the route is considered disconnected. During this time, the source discards the route and tries to establish another failure free path using the ant agents.

3.2 PROPOSED SCHEME

In section 1.4, we have discussed Reliable multicast in MANET and the various protocols used. We have discussed above (section 2) various recent works related to the different protocols used in reliable multicast like the ARQ, Gossip or FEC based. These protocols have there own merits and demerits when used. [15] have proposed a hybrid method called Reliable Multicast data Distribution Protocols (RMDP) which uses the FEC encoding to improve the behaviour of the protocol in presence of large groups of receivers, and to reduce the amount of feedback from receivers. ARQ is used to deal with those cases where the default amount of redundancy does not suffice to complete reception. The RMDP method identifies the drawbacks of both FEC and ARQ method and uses the advantage of the two protocols in order to overcome the drawbacks.

The major drawback of using ARQ single handedly is that it scales very badly to large sets of receivers as well as scalability problems also exist in handling feedback from the receivers. In the same way, FEC is computationally expensive, since the entire data stream must be processed to produce the encoded packets, each one conveying information on a number (possibly as large as k) of source data packets. As in of [15] hybrid method maintains a balance between both the ARQ as well as FEC. The use of FEC techniques to drastically reduce the impact of independent losses for different receivers, which make ARQ-based protocols perform very poorly as the number of receivers grows. The protocol is well-suited to the use with mobile equipment because of its simplicity, robustness to losses, moderate demand for feedback, and scalability.

In our work, as like [15], we introduce a hybrid method of ARQ and FEC. Our method is a two phase technique, where in the initial step we differentiate the data services among the real time data services and non-real time data services. If the data service is a non-real time data services, then the next phase is executed. We use our concept of hybrid method in accordance to the data loss. In general, the service in default uses ARQ method to send data but if there exists an excessive data loss then the system changes over to FEC to send data.

3.1 Phase – 1

In the initial phase, we determine the data services available. We classify the data services into two major groups; the real time services and the non-real time services. The real time data services are basically those information/data which are delivered immediately after collection. There is no delay in the timeliness of the information provided. These are often used for navigation or tracking. [16] These data needs to be sent to the receiver without any time delay even there exist a minimal loss. Therefore we can compromise the losses but the time lagging can not be compromised in the case of real time data services. Similarly the other data services are termed as non real-time services. In these services of non real-time data, the time lagging factors provide less importance but the losses in these service plays a major role.

We consider the two factors of data loss and time lagging of both the services and detect between the two services. As real time data services are less prone to data losses, the information is sent in ARQ process. But in the case of non-real time services, the data loss plays a major role. So we cannot take the ARQ services in the non real-time services, if the losses are high. Thus we detect the losses and if the losses are higher than a threshold level, we shift the services from ARQ to FEC. We discuss this issue in the next section.

3.2 Phase - 2

As discussed above, the default services for sending the data, we consider the ARQ services. But when a non real time data is sent, we periodically determine the losses caused by the ARQ services. If the services cause a higher data loss (above a certain threshold level) in a particular time period, the default ARQ services is changed into an FEC services.

Consider a period λ in which the losses are determined for a non real time data. We analyze a data drop rate (DL) in each period λ. The probability of data loss of DL along with the number of multicast receiver (r) is given as;

$$P(DL,r)=1-(1-D_L)^r \quad (8)$$

Where,

$$DL = \frac{\text{Number of packet dropped}}{\text{Time period}} \quad (9)$$

The above equation state two factors;

- Increase in data drop increases the probability of data loss.
- Increase in receivers along with data drop evolves a higher data loss.

Thus when a probability of losses increases due to either data loss or due to increase in receivers and cross a particular threshold level (P(DL, r)th), the source get informed. The source then changes the ARQ service and adopts FEC services (We evaluate the use of FEC in the next section.). The FEC service is sent throughout the section (till the next sets of data are sent). After the complete of section, the default ARQ services are resumed again. If the probability of the threshold level does not reduce, the FEC service is again resumed or else the ARQ service gets maintained.

3.3 FEC Service

FEC or Forward error correction is a system of error control for data transmission, whereby the sender adds carefully selected redundant data to its messages, also known as an error-correction code. Here we use Luby transform (LT) coding for the FEC service. LT codes are the first class of practical fountain codes that are near optimal erasure correcting codes which employing a particularly simple algorithm based on the exclusive or operation ($\oplus$) to encode and decode the message. [17]

The LT Coding algorithm [18] produces a virtually unlimited number of encoded blocks from some k original data blocks via logical XOR operations. The k original data blocks are obtained by partitioning the original data into k uniform segments and the creation of each encoded block, or "symbol", will require $O(\ln(\frac{k}{\delta}))$ logical operations on the original blocks. To decode the original data with a 1-δ chance of success, any $k+O(\sqrt{k}\ \ln^2(\frac{k}{\delta}))$ encoded blocks should be sufficient.

The encoding process is relatively straight forward.

1. Choose some degree *d* for the next encoded block according to the Robust Soliton Distribution
2. Randomly choose *d* different original data blocks and XOR them together to produce the encoded block.
3. Repeat steps 1 and 2 until the desired number of encoded blocks have been produced.

It should be noted that as each encoded symbol is produced, the identities of its sources must be stored as meta-data for the decoding process.

The process of decoding the data is as follows:

1. When an encoded block is received, XOR it with all of its neighbors in the bipartite graph which have been recovered, and remove the edges that join the XORed nodes.
2. If the encoded block has only one remaining neighbor, then part of the original data has been recovered. Copy its data to its sole neighbor and place that data node in a queue of original nodes to process.
3. While the queue is not empty, choose a data node from the queue. XOR each received neighbor's data with the data in the original node and disconnect the nodes. For each neighbor that is XORed, perform step 2.
4. Continue receiving and processing encoded blocks until the original data has been completely recovered.

Thus our technique of hybrid usage of ARQ and FEC cumulatively produces a reduces loss based scheme which helps the non real time data to maintain loss free even if the number of receivers are increased. This increases the scalability of the network and avoids time-waste for redundancy.

Algorithm

Consider an incoming traffic flow at λ =1, where λ is a given period

1. If the flow is real-time, then
   1.1 flows are transmitted using ARQ
   end if
2. if flow is non-real time, then
   2.1 Flow are transmitted using ARQ
   2.2 determine probability of data loss, P(DL, r)
   2.3 If P(DL, r) > P(DL, r)th , then
   2.3.1 Flow are transmitted using FEC
   2.3.2 After FEC session complete, repeat from 1.
   Else
   2.3.3 Continue the transmission using ARQ
   End if
   End if
3. λ = λ + 1 ,
4. Repeat from 1

IV. SIMULATION RESULTS

4.1 Simulation Model and Parameters

We use NS2 [19] to simulate our proposed technique. The proposed hybrid reliable data transmission (HRDT) technique is applied in our previous multicast routing protocol EERCCP [15]. In our simulation, the channel capacity of mobile hosts is set to the same value: 2 Mbps. We use the distributed coordination function (DCF) of IEEE 802.11 for wireless LANs as the MAC layer protocol. It has the functionality to notify the network layer about link breakage.

In our simulation, 50 mobile nodes move in a 1000 meter x 1000 meter region for 50 seconds simulation time. We assume each node moves independently with the same average speed. All nodes have the same transmission range of 250 meters. In our simulation, the speed of the mobile is 5 m/s. The simulated traffic is Constant Bit Rate (CBR).

Our simulation settings and parameters are summarized in table 1

No. of Nodes	50
Area Size	1000 X 1000
Mac	802.11
Radio Range	250m
Simulation Time	50 sec
Traffic Source	CBR and VBR
Rate	0.5,1,1.5 and 2Mb
Mobility Model	Random Way Point
Speed	5m/s
Receivers	5,10,…25
Pause time	5 s
Transmit Power	0.660 w
Receiving Power	0.395 w
Idle Power	0.335 w
Initial Energy	3.1 J

TABLE1: SIMULATION PARAMETERS

4.2. Performance Metrics

We compare our proposed ARAT protocol with the EERCCP [18] protocol. We evaluate mainly the performance according to the following metrics.

Average end-to-end delay: The end-to-end-delay is averaged over all surviving data packets from the sources to the destinations.

Average Packet Delivery Ratio: It is the ratio of the No. of packets received successfully and the total no. of packets sent.

Throughput: It is the number of packets received by all the nodes in the network.

4.3. Results

In this experiment, we vary the rate as 100, 200…..500Kb.

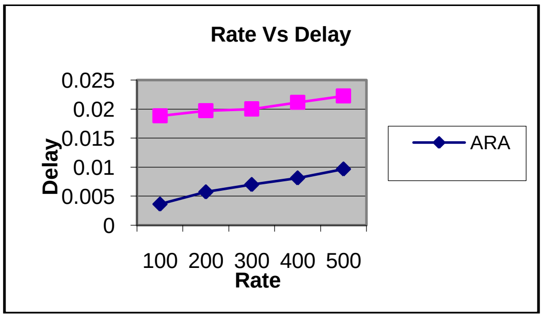

Fig 1: Rate Vs Delay

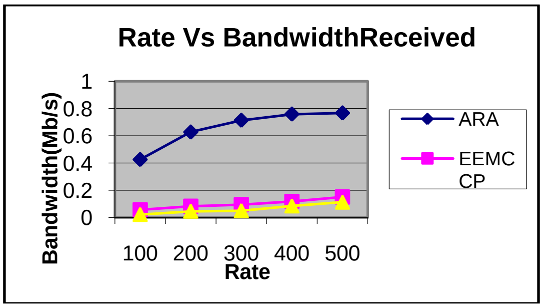

Fig 2: Rate Vs Bandwidth Received

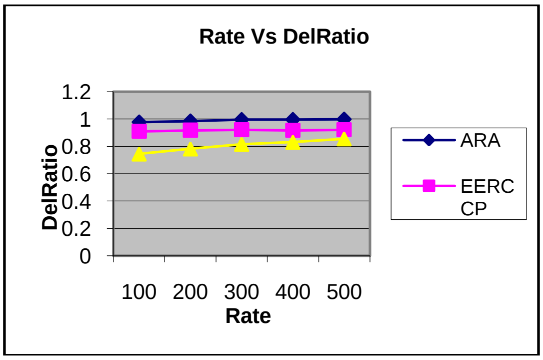

Fig 3: Rate Vs DelRatio

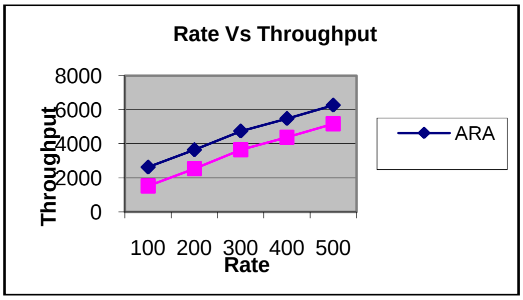

Fig 4: Rate Vs Throughput

Figure 1 show the end-to-end delay occurred for both ARAT and EERCCP. As we can see from the figure, the delay is less for ARAT, when compared to EERCCP.

Figure 2 shows the total bandwidth received for both ARAT and EERCCP. As we can see from the figure, the received bandwidth is high for ARAT, when compared to EERCCP.

Figure 3 shows the delivery ratio for both ARAT and EERCCP. As we can see from the figure, the delivery ratio is high for ARAT, when compared to EERCCP.

Figure 4 shows the throughput occurred for both the cases. As we can see from the figure, the throughput is high for ARAT, when compared to EERCCP.

4.2 Performance Metrics

We compare our (HRDT) technique with existing multicast AODV [18] and RMDP [16]. We evaluate mainly the performance according to the following metrics.

Average end-to-end Delay: The end-to-end-delay is averaged over all surviving data packets from the sources to the destination.

Average Packet Delivery Ratio: It is the ratio of the No. of packets received successfully and the total no. of packets sent.

Average Energy Consumption: The average energy consumed by the nodes in receiving and sending the packets are measured.

Control Overhead: The control overhead is defined as the total number of routing control packets normalized by the total number of received data packets

4.3 Results

A. Varying the Receivers

In this experiment, we vary the group size or the number of receivers per group as 5,10…..25.

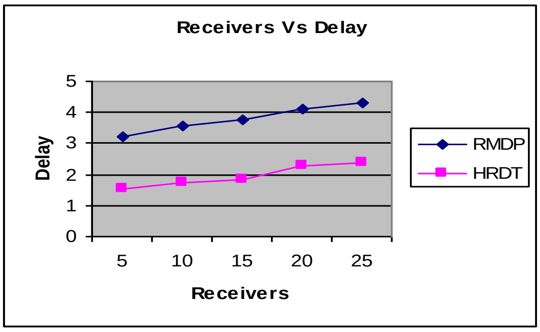

Figure 1: Receivers Vs Delay

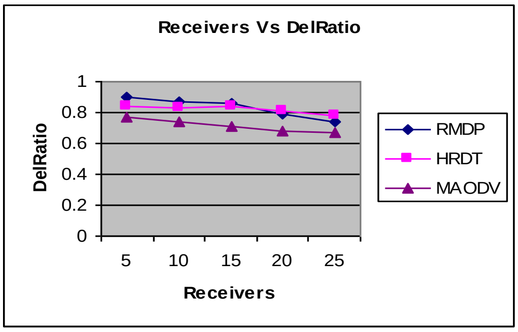

Figure 2: Receivers Vs Delivery Ratio

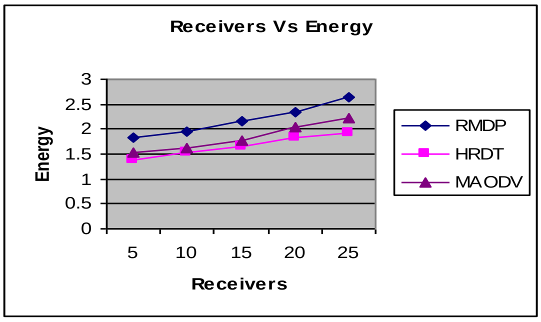

Figure 3: Receivers Vs Energy

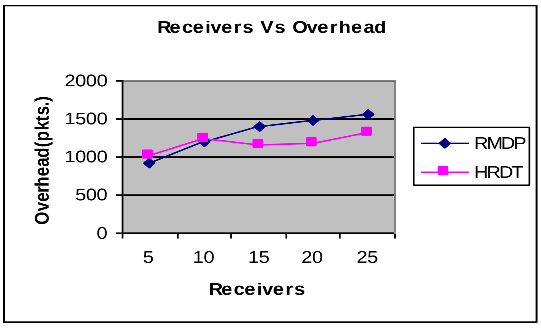

Figure 4: Receivers Vs Overhead

When the number of receivers is increased, we observe the following results.

Figure1 shows the end-to-end delay occurred for both HRDT and RMDP. As we can see from the figure, the delay is significantly less for HRDT, when compared to RMDP. This is because, RMDP is completely FEC based resulting in high delay for encoding and decoding.

Figure2 shows the packet delivery ratio for HRDT, RMDP and MAODV. As we can see from the figure, the delivery ratio is initially less for HRDT than RMDP for the receivers 5,10 and 15, since ARQ suffer from poor performance, when the receivers are increased. But when the receivers are more than 15, it changes to FEC mode, resulting in more delivery ratio than RMDP. Since MAODV does not involve any error recovery features, it has the least delivery ratio

Figure3 shows the energy consumption for HRDT, RMDP and MAODV. The energy consumption is more for RMDP compared to HRDT and MAODV, since FEC requires more energy for encoding and decoding.

Figure4 gives the overhead occurred for both HRDT and RMDP. Cleary the overhead is less in HRDT than RMDP. This is due to the fact that HRDT adaptively changes to FEC, when the receivers are more.

V. CONCLUSIONS

The ARA technique is developed for reserving the bandwidth for real-time applications in MANETs, which contains two ant agents: FAA and BAA. It probes the bandwidth and reserves the necessary bandwidth needed for the real time applications. When the real-time traffic flow has to be transmitted, the temporary resource which is utilized by other traffic flows gets dropped and the real-time flow starts. The scheme also detects the QoS changes and route breakage and performs congestion control by periodical monitoring of ant agents. To provide lossless real time data to the receiver, a Hybrid Reliable Data Transmission (HRDT) technique is developed with Automatic Retransmission reQuest (ARQ) and Forward Error Correction (FEC) features. The HRDT is used in conjunction with the ARA based EEMCC protocol. Among the two traffic services, the non real time data traffic need to be have a lower loss even if there exist a delay and the real-time traffic need minimum delay irrespective of the losses. Since ARQ involves less delay and overhead, the real-time data is transmitted completely using the ARQ technique. But for the non real-time data, the total data loss occurred at the receivers is estimated for a give time period. If the loss is greater than required threshold value, it transmits data using FEC technique since FEC achieves more reliability than ARQ. Once the loss becomes less than the required threshold, again the data is transmitted using ARQ.Thus the proposed scheme not only controls the reliability in a network but also the overhead and scalability issues of the existing ARQ and FEC techniques. Therefore, the proposed Hybrid Reliable Data Transmission based on Ant-agent Resource Allocation Technique in EEMCC Protocol for MANETS gives reliable data transformation.

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