Performance and Comparison between AAMRP, AMR, MANHSI Routing Protocol for Mobile Ad-Hoc Networks

Ritu Kumari† , Navendu Nitin††, Neelesh Agrawal††† and Prof. A.K. Jaiswal††††

† M.Tech.student,Sam Higginbottom Institute of Agriculture,Technology & Sciences,Allahabad,India
††,††† & †††† Shepherd School of Engineering and Technology, Sam Higginbottom Institute of Agriculture,Technology & Sciences,Allahabad,India

Summary

In mobile ad hoc networks, the topology may change frequently and communication links may be broken because of users' mobility then to achieve the multicast communication is a challenging task. Multicasting is effective when its group members are sparse and the speed is low. On the other hand, broadcasting is effective when the group members dense and the speed are high. Multicast and broadcast both can be adopted in different protocols. In this paper, we propose ant agent based adaptive multicast protocol that simplify both multicast and broadcast problem. The proposed protocol, quickly and efficiently establish initial multicast connectivity and/or improved the resulting connectivity via different optimization techniques. By our simulation results, we show that our proposed protocol have lower overhead, packet drop and delay in comparison with a pure multicast protocols.

Key words:
AAMRP, AMR, MANHSI, MANET.

1. Introduction

Over a multicast network, data is sent from the source only once and the network must transmit the data to multiple destinations. Usually multicasting is more efficient for many multimedia applications. In **computer** networking, multicast is the delivery of a message or information to a group of destination computers simultaneously in a single transmission from the source. Copies are automatically created in other network elements, such as routers, but only when the topology of the network requires it. The use of multicasting within a network has many benefits .Multicasting offers optimized network performance, support to distributed applications, resource economy, scalability, more network availability. Instead of sending via multiple unicasts, multicasting Minimizes the link bandwidth consumption, sender and router processing, and delivery delay.

Multicast is used in the environment of mobile ad-hoc network MANET which is very difficult.

A Mobile Ad-hoc [2] network consist of mobile platform which are free to move arbitreaely.A Mobile Ad-hoc network (MANET) is one that comes together as needed, not necessarily with any support from the existing internet infrastructure or any other kind of fixed station. Ad-hoc networks are wireless networks where nodes communicate with each other using multi-hop links. There is no stationary infrastructure or base station for communication. Each node itself acts as a router for forwarding and receiving packets to/from other nodes. Routing in ad-networks has been a challenging task ever since the wireless networks came into existence. The major reason for this is the constant change in network topology because of high degree of node mobility. A number of protocols have been developed for accomplish this task.

In telecommunication and information theory, broadcasting refers to a method of transferring a message to all recipients simultaneously. Broadcasting can be performed as a high level operation in a program, for example broadcasting Message Passing Interface, or it may be a low level networking operation, for example broadcasting on Ethernet. Broadcasting does not require the creation of any delivery structure and also it provides extra robustness in conditions of mobility. Due to this, Broadcasting is used with large group member or in case of high mobility.

Ant agent based adaptive, multicast protocol [1] that exploits group members' desire to simplify multicast routing and invoke broadcast operations in appropriate localized regimes has been proposed. By reducing the number of group members that participate in the construction of the multicast structure and by providing robustness to mobility by performing broadcasts in densely clustered local regions, the proposed protocol achieves lower delay, packet drop and overhead comparable to that with a pure multicast protocol.

2. Existing Work on MANET Multicast Routing Algorithm

Multicast routing algorithm can be categorize in this way

- MANET Multicast routing Algorithm
- Ant based MANET Multicast Routing Algorithm

2.1 Some proposed MANET Multicast Routing Algorithms are

Energy Efficient Multicast Routing Protocol for MANET with Minimum Overhead (EEMPMO) [3]

This protocol reduces the delay problem due to directional diffused forwarding routing and also the network partition problem when a link error occurs due to the failure of primary root. Due to the physical location of the nodes obtained through GLS the route finding process becomes faster, therefore the packets are delivered on a fast pace.

Adaptive QoS Multicast Routing with Mobility Prediction in MANETs [4]

This protocol aware multicast routing algorithm with mobility prediction based on mobile agents. It effectively routes data packets to group members even in case of high mobility and frequent link failures. A set of static and mobile agents are used to carry out route discovery and route maintenance process. This routing path satisfies multiple QoS constraints according to the QoS demand.

Mesh Based Multicast Routing in MANET: Stable Link Based Approach [5]

This protocol indicates the stability based multicast routing scheme in MANET. It finds the multicast routes to receivers by using route request and route reply packets with the help of routing information maintained in MRIC and link stability parameters maintained in link stability database on every node in a MANET. Multicast mesh of alternate paths between every source-destination pair is established in mesh creation phase. Stable path within a mesh is established by choosing an SFN that possess higher value of link stability among its neighbors. This assures better quality of links and minimizes the possibility of link failures and the overhead needed to construct the paths. Link failure conditions are notified to the source with route error packets so as to enable the source to start route discovery for new route establishments.

Minimum Energy Multicast Routing for Wireless Ad-hoc Networks with Adaptive Antennas [6]

This protocol shows a constraint formulation for the minimum-energy multicast problem in wireless ad hoc networks with adaptive antennas. Based on the analysis on the properties of minimum energy multicast tree, the problem can be characterized in a form of mixed integer linear programming problem. Many application scenarios can be solved efficiently based on the formulation using branch-and-cut or cutting planes techniques. The optimal solutions can be used to assess the performance of heuristic algorithms for mobile networks by running them at discrete time instances.

SODMRP: Stable on-Demand Multicast Routing Protocol [7]

This protocol indicates a stable on-demand multicast routing scheme in MANET. The scheme finds stable multicast routes to receivers by considering node's residue energy. It uses a route weighted function in ODMRP route discovery process, to consider both movement and energy information in its operation. Simulation results illustrate that this approach leads to better performance in terms of packet delivery rate, throughput and route life time, in compare with ODMRP and other ODMRP-based protocols.

Multicast AODV (MAODV) [8]

In MAODV, control of the multicast tree is distributed so that there is no single point of failure.

On-Demand Multicast Routing Protocol (ODMRP) [9]

ODMRP applies on-demand routing techniques to avoid channel overhead and improve scalability. It uses the concept of forwarding group, a set of nodes responsible for forwarding multicast data on shortest paths between any member pairs, to build a forwarding mesh for each multicast group.

2.2 Ant based MANET Multicast Routing Algorithm

Ant colony optimization (ACO) [10] is an optimization technique inspired by the exploratory behavior of ants while finding food. Ants start from their nest and find deferent paths to the food. In this context, the local information available to the ant is the path that it took to the destination. However a single ant is not aware of the complete topology of the environment. Ants thus communicate with each other by depositing traces of pheromone as they walk along their path. Subsequent ants that arrive in search of food, base their decisions of which path to take on the pheromone traces left in that locality by the previous ants. This form of communication is indirect, i.e., one ant releases the pheromone information into the environment, and another ant senses that pheromone information from the environment just as Grass's had defined. As more ants travel over a particular path, the concentration of pheromone increases along that path. Pheromones along a path also gradually evaporate decreasing their concentration on that path. The pheromone acts significant stimuli since other ants are able to sense the pheromones deposited by each other, and they generally take the path of maximum pheromone concentration. This is how the ants progressively converge on a single optimum path between their nest and the food.

Srinivas Seth and Siba K.Udgata [11] have proposed an Efficient Ant Routing Protocol for MANET which are based on Ant Colony Optimization principle coupled with other intelligent techniques. The proposed Ant-E algorithm improves the efficiency, robustness and reliability. The efficiency of proposed routing protocol Ant-E is shown to better than other two on demand routing protocols AODV and DSR. The proposed Ant-E routing protocol uses blocking ERS and local retransmission along with principles of ant colony to reduce the end-to-end delay and NRL. It enables optimal path routing and fast route discovery with better PDR and Delay.

Siba K.Udgata , Dharmendra K Singh and Lalan Kumar [12] have presented a Performance Evaluation of ACO Based on Demand Routing Algorithm for Mobile Ad - Hoc Networks In this paper, other evaluated the performance of ACO based, named as Ant Based-on-Demand Routing Algorithm ABDRA with traditional routing protocol AODV for Mobile Ad Hoc Networks using NS-2.29 event simulator. The proposed ABDRA decreases the average end-to-end delay and the times of congestion happening effectively by on demand creating the multiple routes of link disjoint paths. This is because the proposed algorithm uses local updating rule and global updating rule to update the pheromone of link and the probability route table. Also, selects route and balances traffic flows considering bandwidth and probability from routing table. Experimental results show that ABDRA performs better in both the performance matrices i.e. for Packet Delivery Fraction as well as End to End delay.

Mrs. B.D. Shirodkar*, Dr. S.S.Manvi, A.J.Umbarkar[13] have proposed a Multicast Routing for Mobile Ad-Hoc Networks using Swarm Intelligence which indicates that this is an alternative approach to solving the multicast routing problem in mobile ad hoc networks. Multicasting with multiple cores by adopting swarm intelligence is an on demand multicast routing protocol that creates a multicast mesh shared by all the members within each group with other members. Ant agents are used to select multiple cores and these cores use ant agents to establish connectivity with group members

Zeyad M. Alfawaer, GuiWei Hua, and Noraziah Ahmed [14] have introduced MANHSI (Multicast for Ad hoc Network with hybrid Swarm Intelligence) protocol, which relies on a swarm intelligence based optimization technique to learn and discover efficient multicast connectivity. The proposed protocol instances that it can quickly and efficiently establish initial multicast connectivity and/or improved the resulting connectivity via different optimization techniques.

A. Sabari and K.Duraiswamy [1] have proposed an Ant Based Adaptive Multicast Routing Protocol (AAMRP) for Mobile Ad Hoc Networks. Which combines the positive aspects both multicasting and broadcasting.

Diego Pinto, and Benjamin Baron[15] have proposed a new approach for the resolutions of Multi-Objective Problems (MOPs) inspired in Max-Min Ant System (MMAS), where Ant Colony Optimization (ACO) already resolve the single objective combinatorial problems. Multicast traffic engineering Problem was solved using the proposed approach as well as a Multiobjective Multicast Algorithm (MMA), a Multi-objective evolutionary algorithm (MOEA) specially designed for that multicast problem.

3. ANT BASED ADAPTIVE MULTICASTROUTING PRTOCOL FOR MANET

Many current protocols cannot adapt to local variations in network properties. Most of these protocols have static, globally predefined parameters that cannot be adjusted dynamically within localized regimes. AAMRP [1] simplify these problems and it provides

- The localized flexibility in response to changing network condition
- Advantage of broadcasting in high densities

These are obtained by varying the network size and group size. Our objective is that AAMRP keep these properties when bit rate increases.

We know that AAMRP has multicast structure, each group member in AAMRP can be in 3 states. It can be in a temporary mode wherein it is JOINING the session, it can be a cluster LEADER, or it can simply be the MEMBER of a cluster leader. Each node maintains a Group Member Table (GM Table) which contains the information of the joining group members. The information maintained in this table is obtained by means of the ADVERTISE and the LEADER messages. Each cluster leader maintains a Cluster Member Table (CMTable), which contains information of all the cluster group members that are

Associated with the cluster leader. The information maintained in this table is obtained via the reception of MEMBER messages that are sent out by each cluster member.

When the cluster leader receives a data packet from the multicast source, it broadcast it to the group members within its cluster. Here adaptive broadcast is performed, since the maximum broadcast range is depending on the furthest child of the cluster leader. (i.e.), the broadcast range can be reduced as per the distance of the furthest child, stored in the CMTable. Due this adaptive broadcast, redundant and unwanted transmissions of data can be reduced

3.1 Multicast Algorithm

Step1: Backup-paths-set

For each destination node m_i Dijkstra *K* shortest path algorithm [16] is used to compute the least-cost paths from s to m to construct a backup-path set. Let p_i be paths set for destination node *i* :

$P_i = \{P_i^{\,1}..........P_i^{\,j}......P_i^{\,k}\}$ (1)

is the jth path for destination node *i*

If the delay constraint is violated by some of the trees, then the cost is to be increased, so that it is likely to be rejected.

Step2: Tree Formation

In this algorithm, *a* multicast tree *T* is represented as an array of m elements

$T = \{P_1.......P_2.........P_m\}$ (2)

Where $P_i = P(s,m_i)$, is the path set selected from (1), *s* is the source and mi is the destination.

Step3: Path selection

When an ant moves from the node *i* to the next node *j* , the probability function of the ant choosing node *j* as the next node as follows

$$f_{ij} = \begin{cases} \dfrac{[T_{ij}]^{\alpha}[\eta_{ij}]^{P}}{\sum u \in N_h(t)^{[T_{iu}]\alpha[\eta_{iu}]^{\beta}}} & \text{if } j \in N_h(i) \\ 0 & \text{otherwise} \end{cases}$$

Step4: Pheromone update

The pheromone trail associated to every edge is evaporated by reducing all pheromones by a constant factor:

$$\Gamma_{ij} \leftarrow (1-P)\ \Gamma_{ij} \quad (4)$$

Where $p(0,1)$ is the evaporation rate. Next, each ant retracts the path it has followed and deposits an amount of pheromone $\Delta\Gamma_{ij}^{\,h}$ on each traversed connection

$$\Gamma_{ij} \leftarrow \Gamma_{ij} + \Delta\Gamma_{ij}^{\,h}, \quad \alpha_{ij}\text{€}SH \quad (5)$$

The pheromone on a connective path (*i*. *j*) left by the mth ant is the inverse of the total length travelled by the ant in a particular cycle. The formula is as follows

$$\Gamma_{ij}^{\,h} = Q/L_m$$

In the above formula,

Q is a constant, and $Lm = (C_j - C_i)$, where *is* C_i cost of sub multicast tree node *i* and C_j is cost of sub multicast tree node j. To avoid the situation of $Ci = C_j$ compute

$$L_m = (C_j - C_i)^2 + 1$$

Step5: Stopping criterion

The stopping criterion of the algorithm could be specified by a maximum number of iterations or a specified CPU time limit.

4. Experimental Results

4.1 Simulation Setup

NS2 is used to simulate the proposed algorithm. In our simulation, the number of nodes is set to the same value: 100.The distributed coordination function (DCF) of IEEE 802.11 for wireless LANs as the MAC layer protocol is used. It has the functionality to notify the network layer about link breakage. In the simulation, mobile nodes move in a 600 meter x 600 meter rectangular region for 50 seconds simulation time. Initial locations and movements of the nodes are obtained using the random waypoint (RWP) model of NS2. I assume each node moves independently with the same average speed. All nodes have the same transmission range of 250 meters. In this mobility model, a node randomly selects a destination from the physical terrain. It moves in the direction of the destination in a speed uniformly chosen between the minimal speed and maximal speed. After it reaches its destination, the node stays there for a pause time and then moves again.

In the simulation, the maximal speed is 10 m/s. and pause time is 5sec. We vary the bit rate as 50kb, 100kb,150kb , and 200kb and to investigate the performance influence of different topologies. For each scenario, ten runs with different random seeds were conducted and the results were averaged

AAMRP is compared with protocol Ant Based Multicast Routing (AMR) and Multicast for Ad hoc Network with Hybrid Swarm Intelligence (MANHSI) . The evaluation is mainly based on performance according to the following metrics

Control overhead: The control overhead is defined as the total number of routing control packets received.

End to End Delay: It is average end-to-end-delay of the transmission.

Drop: It is average packet drop of the transmission.

4.2 Results

Figure 1 shows that the end to end delay of the AAMRP is lower in comparison with AMR.MANHSI Protocol have constant delay but its value is higher than other two protocols. In the figure we can see that, as the bit rate increases, the corresponding Delay also increases. TABLE: 1 shows the Delay calculation.

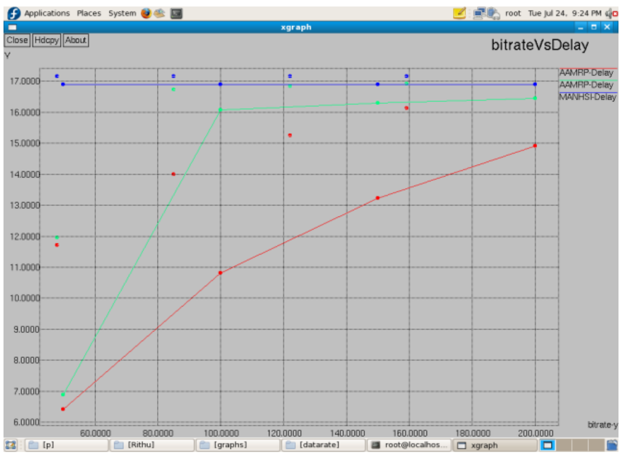

Figure 1: Bit rate Vs End-to-End Delay

TABLE: 1 Delay calculation.

BitRate	AAMRP	AMR	MANHSI
50kb	6.415094	6.882461	16.896302
100kb	10.820030	16.077664	16.896302
150kb	13.229309	16.294499	16.896302
200kb	14.910527	16.452385	16.896302

Figure 2 shows the Drop of all the protocols .In the figure we can see that AAMRP have lower Drop other than two protocols. Again MANHSI have constant Delay throughout but its value is higher than two protocols TABLE: 2 show the Drop calculation

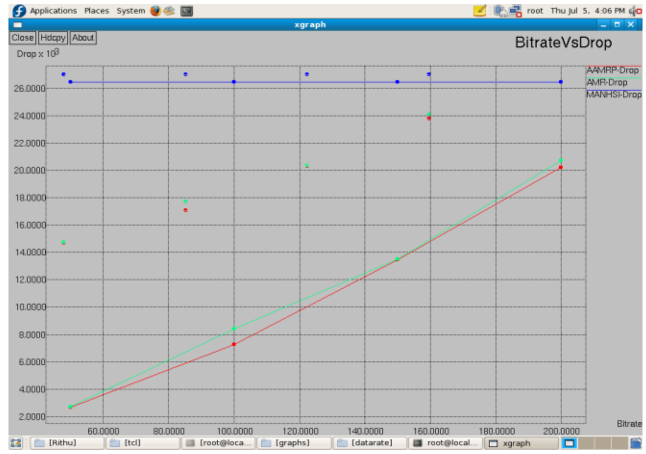

Figure 2: Bit Rate Vs Drop

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TABLE: 2 Drop calculations.

BitRate	AAMRP	AMR	MANHSI
50kb	2669	2730	26465
100kb	7249	8423	26465
150kb	13455	13513	26465
200kb	20225	20736	26465

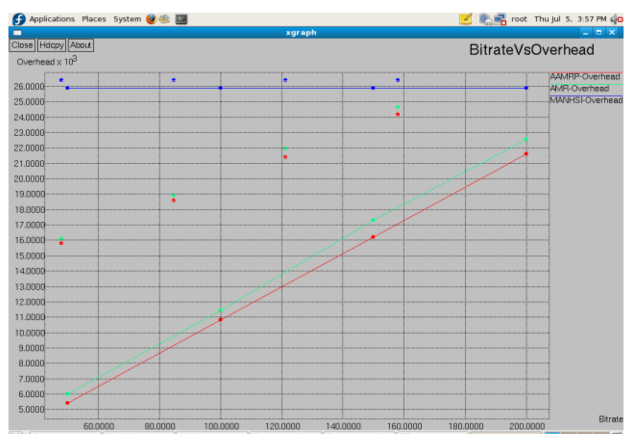

Figure 3: Bit Rate Vs Overhead

Figure 3 shows the control overhead occurred in the entire protocols .From figure we can observe that the control overhead increases when bit rate increases.TABLE:3 show the Overhead calculation.

TABLE 3: Overhead calculation

Bit rate	AAMRP	AMR	MANHSI
50kb	5420	5991	25882
100kb	10824	11458	25882
150kb	16216	17297	25882
200kb	21607	22557	25882

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5. Conclusion

In this paper, we have proposed ant agent based adaptive multicast protocol which combines the positive aspects both multicasting and broadcasting .It desire to simplify multicast routing and invoke broadcast operations in appropriate localized regimes. The proposed protocol achieves packet delivery statistics that are comparable to that with a pure multicast protocol but with significantly lower overheads. By our simulation results, we have shown that our proposed protocol achieves reduced overhead, routing load and delay.

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Er.Ritu Kumari received B.Tech Degree in electronics and communication from R.P.SHARMA institute of technology (RPSIT),Patna,Bihar in 2006 and pursuing M.Tech in communication system Engg.from Sam Higginbottom Institute of Agriculture Technology and Sciences,Allahabad,India.

Er. Navendu Nitin received B.Tech Degree in Electronics and Communication Engg. from Sam Higginbottom Institute of Agriculture Technology and Sciences in 2007, and M.Tech degree in Advance Communication System Engg. from Sam Higginbottom Institute of Agriculture Technology and Sciences in 2009. She is currently working in Sam Higginbottom Institute of Agriculture Technology and Sciences as an Assistant Professor in Department of Electronics and Communication Engg.

Er. Neelesh Agrawal received B.Tech Degree in Electronics and Communication Engg. from Sam Higginbottom Institute of Agriculture Technology and Sciences in 2006, and M.Tech degree in Advance Communication System Engg. from Sam Higginbottom Institute of Agriculture Technology and Sciences in 2009. He is currently working in Sam Higginbottom Institute of Agriculture Technology and Sciences as an Assistant Professor in Department of Electronics and Communication Engg.

Prof. A.K. Jaiswal is working as professor and HOD in the department of ECE at Sam Higginbottom Institute of Agriculture Technology and Sciences,Allahabad.He worked for the promotional activities in optical fibre communication system sponsored by Government of India, in association with IIT Kharagpur and Madras. His research interests are Optical system, sensors and networks.