An Adaptive Fuzzy Clustering and Location Management in Mobile Ad Hoc Networks

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ABSTRACT

In the typical Ad Hoc networks application, the network hosts usually perform the given task according to groups, e.g. the command and control over staff and accruement in military affairs, traffic management, etc. Therefore, it is very significant for the study of multicast routing protocols of the Ad Hoc networks. Multicast protocols in MANETs must consider control overhead for maintenance, energy efficiency of nodes and routing trees managements to frequent changes of network topology. Now-a days Multicast protocols extended with Cluster based approach. Cluster based multicast tree formation is still research issues. The mobility of nodes will always increase the communication delay because of re-clustering and cluster head selections. For this issue we evaluate Adaptive Fuzzy System (AFS) to multicast communication in mobile ad hoc networks (MANETs). To evaluate the performance of AFS, we simulate the fuzzy clustering in a variety of mobile network topologies in NS-2 and compare it with Cluster-based On Demand Multicast Routing Protocol (CODMRP) and Cluster-based routing protocol (CBRP). Our simulation result shows the effectiveness and efficiency of AFMR: high packet delivery and overhead are the lowest.

Keywords

Fuzzy Clustering, CODMRP, CBRP, Kalman Filter and Location Management.

1. INTRODUCTION

A Mobile Ad-hoc Network (MANET) is a temporary wireless network composed of mobile nodes, in which an infrastructure is absent. There are no dedicated routers, servers, access points and cables. If two mobile nodes are within each other's transmission range, they can communicate with each other directly. Otherwise, the nodes in between have to forward the packets for them. In such a case, every mobile node has to function as a router to forward the packets for others. Traditional routing protocols used in hardwired networks, such as distance vector protocols (e.g. RIP) and link state protocols (e.g., OSPF) cannot be implemented in the MANET directly for various reasons [2]. There are many applications and services are achieved by multicast routing such as video conferencing, distance learning and video on-demand, etc. Based on the topology the existed ad hoc multicast routing protocols are classified into two categories i.tree based ii.mesh based. The tree based routing scheme has only one path between the source to receiver. MAODV, AMRIS, AM Route are the best examples for the tree based scheme. But, the mesh-based routing scheme has multiple redundant paths between the sources to receivers. ODMRP, CAMP is the typical examples of mesh-based scheme [2]. Both are giving some salient features to mobile ad hoc networks [3]. Among which, the performance of ODMRP is the best one with the advantages of considerable throughput and fitness for high-speed movement, etc. However, ODMRP that makes use of the flood-control information to build group multicast deliver mesh suffers heavy overheads, meanwhile, the deliver number of redundant data by unoptimalized mesh is so heavy that transformation efficiency is not high, and the ODMRP is difficult to adapt itself to the bad environment of single-direction link. In addition, the network topology of ODMRP is flat structure. As the number of nodes in networks and the scope of network become larger, real-time building and maintaining a mesh on demand will become worse. If multicast routing protocol based on hierarchical topology structure is adopted, it not only enable the networks to obtain good extension, but also improve the throughput of the networks through the partialization of route information, as well as reduce the overhead of route controlling messages[5].

1.1 Types of Clustering in MANETs

Clustering can be classified in to following types, distributed and hybrid clustering

- Centralized Clustering **-** It is the one in which, a centralized architecture is used in the clustering process i.e. a fixed CH and the remaining nodes in the cluster act as member nodes. If a centralized architecture is used in a MANET and the central node fails, the entire network will collapse and hence there is no guarantee for reliability in centralized clustering mechanism.
- Distributed Clustering **-** It is one in which, there is no fixed central CH and this keeps on changing from node to node based on some parameters, for instance residual energy. Distributed architecture is used in MANETs for some specific reasons like mobile nodes prone to failure, better collection of data and provide backup in case of failure of the central node. Also, nodes sensing and forwarding the redundant information can be minimized. Since there in no centralized body to allocate the resources, they have to be self-organized.
- Hybrid Clustering **-** It is formed as the resulting combination of both the above mentioned mechanisms [8].

Routing protocols for mobile ad hoc networks are classified as follows [18]

1.2 Multicast Routing Protocols

Although multicast transmission has not been widely deployed in the current MANET, it will become very important in multimedia communications in the near future. To send a data packet to multiple receivers in the MANET simultaneously, the simplest method is to resort to broadcast. However, broadcast consumes considerable bandwidth and power, which should be avoided as much as possible.
There have been many multicast routing protocols proposed for MANET. According to their underlying routing fabrics, they could be divided into two groups: tree-based protocols and mesh-based protocols.

1.2.1 Tree-based multicast routing protocols

The tree-based protocols originate from their counterparts in hardwired networks. The group members and (possibly) some non-members form a shared multicast tree. When the sender sends out a data packet, the receiver receives it from its upstream node in the tree and forwards it along the downstream links in the tree. Because only the tree members participate in the packet transmission, a lot of bandwidth is saved compared to pure broadcast.

Some tree-based multicast routing protocols are MAODV, AMRoute, and AMRIS.

1.2.1.1 Multicast Ad-hoc On-Demand Distance Vector Routing Protocol

AODV is one of widely tested unicast routing protocols. It was extended to support multicast routing in the MANET . The basic operations in multicast routing are similar to those in unicast routing, except for a little modification.

In unicast routing operations, every destination has a unique sequence number. Likewise, every multicast group also has a sequence number to indicate the freshness of the multicast routing information. Thus, one and only one group leader is elected to broadcast periodical GROUP HELLO messages throughout the MANET to maintain the sequence number. The group leader is by default the first node joining the group, but could also be another node when the first node leaves the group.

To support multicast transmission, a multicast tree is formed on-demand to include all the group members and some non-members which are relay nodes. The process of building such a tree is similar to the route discovery procedure in unicast routing: every time when a node wants to join a multicast group or to send a data packet to a multicast destination (while it does not have the proper routing entry), a RREQ message is broadcast throughout the MANET. The nodes in the multicast tree for this group send back a RREP message. The nodes forwarding RREQ and RREP record the path backwards to the source of packet, as they will do in unicast routing. On receipt of multiple RREP packets, the node chooses one branch of the multicast tree and connects to it, thus a loop is avoided.

When a link breakage is detected due to node movement, the node which is farther away from the group leader initiates local repair. Again, it broadcasts a RREQ message and waits for RREP from the group leader. By this means the tree is reconstructed to accommodate the topological change.

1.2.1.2 Adhoc Multicast Routing Protocol

Adhoc Multicast Routing Protocol (AMRoute) is another tree-based multicast routing protocol. Unlike MAODV, it has the following properties:

(1) The routing protocol builds a user-multicast tree, in which only the group members are included;

(2) Because non-members are not included in the tree, the links in the tree are virtual links. In other words, they are in fact multi-hop IP-in-IP tunnels;

(3) AMRoute depends on the underlying unicast routing protocol to deal with network dynamics, although it has no favor for unicast routing protocols.

Like MAODV, there is only one logical core in the multicast tree, which is responsible for group member maintenance and multicast tree creation.

The multicast operation in AMRoute consists of the two steps:

Mesh creation

In the very beginning, a group member is the core for its own 1-node mesh and begins to broadcast JOIN_REQ messages periodically. When a group member (which is a core currently) receives such a message from another core, it answers with a JOIN_ACK message, which means the two cores find each other. Thus, the two 1-node meshes merge, which leads to only one member elected to be the core for the new mesh. A bi-directional tunnel is built between these two nodes at the same time. As a result, a mesh forms from a scratch which includes all the group members.

Tree creation

The core of the mesh broadcasts periodic TREE_CREATE messages throughout the mesh (along the tunnels). On receipt of this message, a group member chooses one mesh link from which it receives the message to be the tree link and ignores the other duplicate messages. A TREE_CREATE_NAK message is sent back along the ignored the mesh links to prune the mesh links from the multicast tree. Depending on the mobility pattern and bandwidth, a ACK-based scheme could be used instead to indicate the mesh link to be tree link.

1.2.1.3 Ad hoc Multicast Routing protocol utilizing Increasing id-numberS

The third tree-based routing protocol is Ad hoc Multicast Routing protocol utilizing Increasing id-numberS (AMRIS) [28]. In AMRIS every node is assigned an id-number. The source of the multicast session has the smallest id. As to other group members, their ids increase with their distance from the source.

To build a delivery tree, the source generates its own msm-id and then broadcasts a NEW-SESSION message throughout the MANET. During that time, every node chooses its own msm-id which is larger than the one contained in the message and forwards its new msm-id. Thus, every node has an msm-id. When a node wants to join the multicast session, it chooses one of its neighbors which has the smaller msm-id as its parent and send it a JOIN-REQ message. If the neighbor is in the tree (if the tree has been built), it answers with a JOIN-ACK message, which means the joining is successful; otherwise (when it is the first time to build the tree), the neighbor forwards JOIN-REQ to its own neighbors and waits for the reply, which is repeated until the JOIN-REQ arrives at an on-tree node or the source. As a result, a delivery tree rooted from the source is formed to include all the group members and some relay non-members.

Every group member broadcasts a one-hop beacon message to maintain link availability. If a link is broken, the node with a larger msm-id tries to reconstruct the branch. If it's within one-hop distance of another group member, it will re-join the delivery tree after it receives the beacon message from its on-tree neighbor; otherwise, it broadcasts a JOINE-REQ message.

1.3 Mesh-based Multicast routing protocols

This group of multicast routing protocols use a mesh instead of a share multicast tree for packet delivery, which provides redundant links among group members. Compared with tree-based routing protocols, they may consume more bandwidth. However, they are more resilient to network dynamics.

Examples of mesh-based routing protocols are ODMRP and NSMP.

1.3.1 On-Demand Multicast Routing Protocol

On-Demand Multicast Routing Protocol (ODMRP) [29] is a reactive multicast routing protocol. The source establishes and maintains group membership and multicast mesh on demand if it needs to send data packets to the multicast group, which is somewhat similar to MAODV. However, it builds a mesh instead of tree for packet transmission. A set of nodes, which is called forwarding group, participate in forwarding data packets among group members. When a source node needs the route to a multicast group, it begins to periodically broadcast a JOIN REQUEST message, which is forwarded by all the nodes in the MANET. When a group member receives

such a message, it records the IP address of the node upstream to be the next hop for the source, and broadcasts a JOIN TABLE to its neighbor. On receipt of the JOIN TABLE, the neighbor node examines the table to see if it is the next hop for the source in one entry. If the answer is positive, the node sets itself to be a forwarding node and broadcasts its own JOIN TABLE to its neighbors as well. Thus the JOIN TABLE is sent back until is reaches the source. At that time the forwarding group is formed and the route is built. From then on the data packets can be delivered to the receivers properly.
The other notable properties about ODMRP are:
(1) All the states in ODMRP are soft states, which are refreshed by the control messages mentioned above or data packets, which achieves higher robustness;
(2) ODMRP is not only a multicast routing protocol, but also provides unicast routing capability.

1.3.2 Neighbor Supporting Ad hoc Multicast Routing Protocol

Another mesh-based multicast routing protocol is Neighbor Supporting Ad hoc Multicast Routing Protocol (NSMP) [30]. In NSMP, the source, relaying nodes, and the receivers are designated as forwarding nodes, which form a multicast mesh. All the nodes that are adjacent to at least one forwarding node are designated as neighbor nodes.
When a source needs the route to other group members, a route discovery procedure is initiated to build the mesh: a FLOOD_REQ message is forwarded by all the nodes and a REP message is sent back by every group members, which works similarly with ODMRP.
The difference between them is that the source node in ODMRP periodically broadcast route request packet throughout the network for purpose of group and route maintenance, while NSMP limits the scope of broadcast of such packets to the set of forwarding nodes and neighbor nodes after the mesh is built. Due to node locality, link breakage can be easily repaired by the scoped broadcasting.

Table. 1 Characteristic summary of multicast routing protocols

	MAODV	AMRoute	AMRIS	ODMRP	NSMP
Routing fabrics	Tree	Tree	Tree	Mesh	Mesh
Virtual link	No	Yes	No	No	No
Route building	Reactive	Proactive	Reactive	Reactive	Reactive
Group Coordinator	Group leader	Core	Sender	Sender	Sender
Group maintenance	Periodical Group HELLO messages	Periodical TREE_CREATE messages	Group member beacon messages	Periodical JOIN_REQ messages	Periodical LOCAL_REQ messages
Route initiator	Sender / Group member	Core	Sender / Group member	Sender	Sender / Group member
Route maintenance	Global broadcast	Depending on the underlying unicast routing protocol	Scoped broadcast	N/A	Scoped broadcast

Thus, considerable bandwidth is saved compared to ODMRP. In case of network partition and new neighbors joining, NSMP resorts to global flooding. Table. 1 gives a characteristic summary and comparison of the multicast routing protocols.A performance comparison of several multicast routing protocols (ODMRP, CAMP, AMRIS, AMRoute, and flooding) was conducted in [31]. Generally speaking, mesh-based multicast routing protocols outperform tree-based counterparts in the terms of packet delivery ratio in the scenario of high mobility because of redundancy of multiple paths among group members. However, the overhead of the former is greater than the latter for the same reason. Within tree-based routing protocols, AMRoute performs the worst due to temporary loop formed in the tree creation and inefficiency of delivery tree composed of virtual links.
Problems in Cluster-Based routing are the tree reconstruction of cluster-based multicast routing protocol will take place if any link of the trees has malfunction or the nodes move out of the link, therefore, its robust performance is unsatisfactory. So disconnection of one link may not affect the transformation of multicast packets. And another one is Cluster heads have high communication task, So Cluster head will failure due to lack of energy. However, the stability of the cluster heads is very important to the networks and non ideal cluster heads is possible to the "bottle-neck" of the networks [4]. The Kalman filter is the best possible (optimal) estimator for a large class of problems and a very effective and useful estimator for an even larger class. With a few conceptual tools, the Kalman filter is actually very easy to use. By using kalman filter we can predict the location updates within clustered groups, each CH gets their neighbors locations.CH also exchange their position to members.CH keeps tracks of nodes position it will leads to predicts the new cluster head based on mobility.CH also predict neighbors' future directions.
The CODMRP refers to the advantages of fitness for high-speed movement of mesh-based ODMRP, and adopts an Enhanced Weighted Clustering Algorithm (EWCA) to assure the stable hierarchical topological structure, so as to form the ad hoc networks (MANETs), namely AFMR and CBRP. One of the chief contributions of this work is our objective analysis of these two multicast routing protocol categories in order to characterize their behavior under a wide range of MANET mobility. In this paper, we evaluate the performance of AFMR and compare it with Cluster-based On Demand Multicast Routing Protocol (CODMRP) and Cluster-based routing protocol (CBRP).

2. RELATED WORKS

Shekhar H M P, Arun Kumar M A, and K S Ramanatha have presented an efficient Mobile Agents Aided Multicast Routing (MAMR) protocol which overcomes these limitations. The protocol was a hybrid protocol where intelligent mobile agents can been integrated with existing on-demand multicast routing protocols such as Multicast Ad Hoc On-demand Distance Vector (MAODV) routing protocol, On demand Multicast Routing Protocol (ODMRP) routing protocol and others[1]. Neha Gupta, Er. Manish Shrivastava and Angad Singh developed a cluster-based routing on demand protocol. In this they used clustering's structure for routing protocol. Clustering is a process that divides the network into interconnected substructures, called clusters. ODRP creates routes on demand so they suffer from a route acquisition delay, although it helps reduce network traffic in general [2].

R. Pandi Selvam and V.Palanisamy have designed a cluster-based multi source multicast routing protocol with new cluster head election, path construction and maintenance techniques. They compute the maximum performance of proposed routing protocol in various environments, and also it compared with Multicast Ad-hoc On-Demand Distance Vector (MAODV) and On-Demand Multicast Routing Protocol (ODMRP) to prove the performance of delivery ratio, control overhead and forwarding efficiency [3]. XUE-MEI SUN, WEN-JU LIU, ZHI-QIANG ZHANG and YOU ZHAO have developed a Cluster-based On Demand Multicast Routing Protocol (CODMRP) to the lack of extension of flat multicast routing protocols in Ad Hoc networks of large scale. [4].

XUE-MEI SUN, WEN-JU LIU, ZHI-QIANG ZHANG and YOU ZHAO have proposed a Cluster-based On Demand Multicast Routing Protocol (CODMRP) to the lack of extension of flat multicast routing protocols in Ad Hoc networks of large scale. CODMRP refers to the advantages of fitness for high-speed movement of mesh-based ODMRP, and adopts an Enhanced Weighted Clustering Algorithm (EWCA) to manage hierarchically its motion nodes, and forms the forwarding group mainly based on cluster heads [5]. Bey-Ling Su, Ming-Shi Wang and Yueh-Ming Huang proposed the fuzzy modified AODV (FMAR) multicast routing protocol to select two comparably stable routes by computing dynamic route lifetime for multicast routing or layered video streaming [6]. Jong-Myoung Kim, Seon-Ho Park, Young-Ju Han and Tai-Myoung Chung presented a cluster head election mechanism–CHEF. They evaluated CHEF compare with LEACH using the mat lab. The simulation results show that CHEF is 22.7% more efficient than LEACH. This is because the energy and local distance is considered in electing cluster heads. [7]. Roberto Carlos Hincapi, Blanca Alicia Correa and Laura Ospina investigated a survey on clustering techniques for MANET. Some preliminary concepts that form the basis for the development of clustering algorithms are introduced. These related issues have to do with the network topology, routing schemes, graph partitioning and mobility algorithms [8].

Rajendra V. Boppana and Xu Su presented quantitative evaluations of false positives in monitoring-based intrusion detection for ad hoc networks. They showed that, even for a simple three node configuration, an actual ad hoc network suffers from high false positives. They validated the experimental results using discrete-time Markov chains and probabilistic analysis [9]. Rui Huang and Gergely V. Z Aruba proposed a mechanism that allows non-GPS-equipped nodes in the network to derive their approximated locations from a limited number of GPS-equipped nodes. In their method, all nodes periodically broadcast their estimated location, in term of a compressed particle filter distribution. Non-GPS nodes estimate the distance to their neighbors by measuring the received signal strength of incoming messages. A particle filter is then used to estimate the approximated location, along with a measure of confidence, from the sequence of distance estimates [10]. Zhaowen Xing, Le Grunewald and K.K. Phang presented a robust weighted clustering algorithm, called PMW (Power, Mobility and Workload), to form and maintain more stable clusters. In PMW, the weight of each node is calculated by its power, mobility and workload, which can be easily collected and computed locally and cover the major factors that cause re-clustering. Clustering overhead of PMW is analyzed [11]. J. D. Mallapur, S. S. Manvi and D. H. Rao have proposed a scheme for constructing a multicast tree based on a spanning tree by employing a fuzzy controller. Fuzzy controller uses three fuzzy input parameters namely, link bandwidth, link delay and link reliability for the construction of multicast spanning tree [12].

Byung-Jae Kwak, Nah-Oak Song and Leonard E. Miller proposed measure is consistent because it has a linear relationship to the rate at which links are established or broken for a wide range of mobility scenarios, where a scenario consists of the choice of mobility model, the physical dimensions of the network, the number of nodes. [13]. Dewan Tanvir Ahmed discussed different multicasting protocols, their deployment issues and provides some guidelines for the researchers in this field [14]. Shahram Nourizadeh, Y.Q. Song and J.P. Thomesse proposed a decentralized algorithm to organize an ad hoc sensor network into clusters by using Fuzzy Logic. Each sensor uses a Fuzzy decision making process to find the best Cluster Head. Simulation showed that this protocol is able to dynamically adapt to network mobility and also shows that with fuzzy logic we have stable clusters and so a cluster head have greater lifetime [15].ZHAO Chun-Xiao and WANG Guang-Xing investigated the use of fuzzy control techniques. For each metric, a fuzzy membership function was defined to predict a more stable link. A fuzzy-inference rule base was implemented to generate the fuzzy cost of each link. A degree clustering algorithm based on a mobility prediction scheme was proposed in a scalable manner [16]. K. Venkata Subbaiah and Dr. M.M. Naidu have proposed a cluster head election scheme using fuzzy logic system (FLS) for mobile ad hoc wireless networks. They used three descriptors: distance of a node to the cluster centroid, its remaining battery capacity, and its degree of mobility. The linguistic knowledge of cluster head election based on these three descriptors is obtained from a group of network experts. [17].

3. ROUTING PROTOCOLS

3.1 Cluster-Based Routing Protocol (CBRP)

In Cluster Based Routing protocol (CBRP) the nodes are divided into clusters. Each node maintains a neighbor table. For each neighbor, the neighbor table of a node contains the status of the link (uni- or bi-directional) and the state of the neighbor (cluster-head or member). In CBRP routing is done using source routing. In forwarding a packet if a node detects a broken link it sends back an error message to the source and then uses local repair mechanism. CBRP and all those who focus on achieving routing in small partition of network face the same type of problems. One important issue is connectivity among individual clusters. Network formation in such design is another issue i.e. how nodes will be allocated to different clusters or in zones such as in ZRP. It is mentioned in the specification of CBRP that new joining inside a cluster is based on broadcasting a message. But it is not cleared how nodes know in advance which cluster it wants to join. Moreover if the node receives replies from more than one clusters then how it will make its joining decision. Likewise in the case of clusters what scheme CBRP utilizes to aware all the cluster-heads about all other cluster-heads in the network. Specification details some error recovery mechanism but is silent about issues such as link satiability between clusters [2].

3.2 Cluster-based On Demand Multicast Routing Protocol (CODMRP)

In 2006 XUE-MEI SUN, WEN-JU LIU, ZHI-QIANG ZHANG and YOU ZHAO, "CODMRP: Cluster-based On Demand Multicast Routing Protocol", In this paper proposed a Cluster-based On Demand Multicast Routing

Protocol (CODMRP) to the lack of extension of flat multicast routing protocols in Ad Hoc networks of large scale. CODMRP refers to the advantages of fitness for high-speed movement of mesh-based ODMRP, and adopts an Enhanced Weighted Clustering Algorithm (EWCA) to manage hierarchically its motion nodes, and forms the forwarding group mainly based on clusterheads. In CODMRP, to establish a mesh for each multicast group, it also uses the concept of forwarding group. The forwarding group is a set of nodes responsible for forwarding multicast data on shortest paths between any member pairs. A clusterhead becomes a mesh member if it is between multicast sources and receivers. The main distinctness between the CODMRP and the ODMRP is the composing of mesh. The mesh of CODMRP is composed by source, clusterhead and destination nodes, in which the destination nodes are clusterheads and cluster members. In ODMRP, group members and multicast routes are established and updated by the source "on demand." Similar to on-demand unicast routing protocols, a request phase and a reply phase comprise the protocol. While a multicast source has packets to send, it floods a member advertising packet with data payload piggybacked to its clusterhead. This packet which is called JOIN QUERY and includes the source node, source clusterhead node and multicast group IDs is periodically broadcasted to the entire network to refresh the membership information and update the routes as follows. When a non multicast source wants to become a multicast member, it broadcasts the JOIN QUERY to its clusterhead, and if its clusterhead is not a multicast group member its clusterhead will continue to broadcast the JOIN QUERY to its neighbor clusterhead. When a cluster head node receives a nonduplicate JOIN QUERY, it stores the upstream clusterhead node ID into the routing table, and re-broadcasts the packet to its cluster members with small power and its neighbor cluster heads with big power, and examines whether itself and its cluster members are destination nodes. If itself is the destination node, the clusterhead node broadcasts the JOIN REPLY to the source clusterhead, If its cluster members are the destination nodes, then its cluster members broadcast the JOIN REPLY to it. When a cluster head node receives a nonduplicate JOIN REPLY, it checks if the next clusterhead node ID in the package matches its own ID. If it does not, it discards the package; If it does, the clusterhead node realizes that it is on the path to the source and thus is part of the forwarding group. It then sets the Forwarding Group Flag(FG_FLAG) and broadcast with big power its own JOIN REPLY built upon matched entries. The JOIN REPLY is thus propagated by each forwarding group member composed clusterheads until it reaches the multicast source clusterhead via the shortest path.

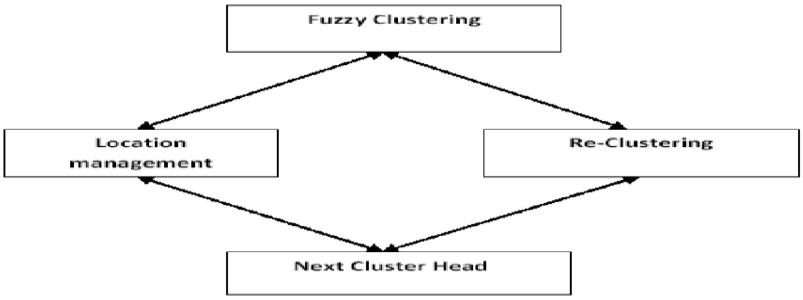

Fig. 1 AFS Protocol Architecture

When a multicast source clusterhead receives a nonduplicate JOIN REPLY, it finds that itself is the source ID of JOIN REPLY, then it broadcasts with small power the JOIN REPLY to its cluster members. This process constructs (or updates) the routes from sources to destination nodes and builds a mesh (the "forwarding group") which is constructed by source, destination and clusterhead nodes. In the CODMRP, if a multicast source wants to leave the multicast group, it only stops broadcasting the JOIN QUERY; if a receiver wants to leave the multicast group, it only stops broadcasting the JOIN REPLY. A forwarding group member will be lowered to a non forwarding group node if it is not updated before the overtime. Moreover, the CODMRP adopts the passive acknowledgments mechanism in order to assure the reliable transmission.

3.3 Adaptive Fuzzy System (AFS)

Adaptive Fuzzy System (AFS) is solve reclustering delay in MANETs. Our proposed protocol is three phases; cluster based multicast tree formation, localized clustering and data transfer. The cluster formation is by the calculating the weighted factor of each node has to become the cluster-head by considering two fuzzy memberships like its remaining battery capacity, and its degree of mobility node with respect to the entire cluster. The nodes send data to the respective cluster -heads, which in turn compresses the aggregated data and transmits it to the group members. For a MANET we make the following assumptions:

• Due to node mobility cluster tree formation and cluster head selection is consider heavy control overhead.
• Location based cluster evaluation is considering for future multicast routing.

In our protocol approach, Considering MANET'S are meant to be deployed over a geographical area with the main purpose of sensing and gathering information, we assume that nodes have minimal mobility, thus sending the location information during the initial setup phase is sufficient

3.3.1 Fuzzy Cluster Formation

We evaluate the cluster formation is based on the following two fuzzy membership functions:

• Node Remaining Energy - energy level available in each node, designated by the fuzzy variable energy
• Node Mobility - a value which classifies the nodes based on how central the node is to the cluster, designated by the fuzzy variable mobility.

The linguistic variables used to represent the node energy and node concentration, are divided into three levels: low, medium and high, respectively, and there are three levels to represent the node mobility: close, adequate and far, respectively. The outcome to represent the node cluster-head election chance was divided into six levels: small, very small, rather medium, medium, large, and very large. The fuzzy rule base currently includes rules like the following: if the energy is high and the centrality is close then the node's cluster-head election chance is very large. All the nodes are compared on the basis of chances and the node with the maximum chance is then elected as the cluster-head.

Each node in the cluster associates itself to the cluster-head and starts transmitting data.

To do this, we averaged the centroids of all the responses for each rule and used this average in place of the rule consequent centroid. Doing this leads to rules that have the following form: IF remaining battery capacity (w1) of node F1 1, and its degree of mobility (x3) is Fl 3, THEN the possibility that this node will be elected as a cluster head (ch) is cl avg, where l == 1, 2, 3...9.

$$C^1 = \frac{\sum^6 i=1\, w_i^1 c_i^1}{\sum^6 i=1\, w_i^1} \quad \text{....... (1)}$$

3.3.2 Location Updates by Kalman Filter

In general, location management may follow two strategies: location updating and location prediction. Location updating is a passive strategy in which each CH periodically broadcasts its position to the neighboring nodes. Location prediction is a dynamic strategy in which cluster members proactively estimate the location of their neighboring CH. In this case, the tracking efficiency depends on the accuracy of the mobility model and on the efficiency of the prediction algorithm. We use Voronoi diagrams to limit the scope of CH initiated location updates. The Voronoi diagram of a set of discrete sites partitions the plane into a set of convex polygons such that all points inside a polygon are closest to only one site. For their properties and ease of computation, Voronoi diagrams have been previously applied to the area of MANTs. The Kalman filter provides a computationally efficient set of recursive equations to estimate the state of such process, and can be proved to be the optimal filter in the minimum square sense. The joint use of Kalman filter at the cluster head and members sides enables reducing the number of necessary location updates. In fact, the filter is used to estimate the position at the actor based on measurements, which is a common practice in robotics, and to predict the position of the CH (i) at the members, thus, reducing the message exchange. The position of CH can be estimated and predicted at the members in its Voronoi cell, based on the measurements ziK taken at the actor and broadcast by the actor. At step k, each member's m in i's Voronoi cell updates the state (that represents position and velocity of the ch) based on the equations. The position observed by the actor at step k is related to the state by the measurement equation

$$Z_i^k = Hx_i^k + Cv_i^k \quad \text{.......... (2)}$$

Where represents the observed position of the actor at step k, and where H = [I ,0], C =B. I = [1 0; 0 1]. B = [0 / B];

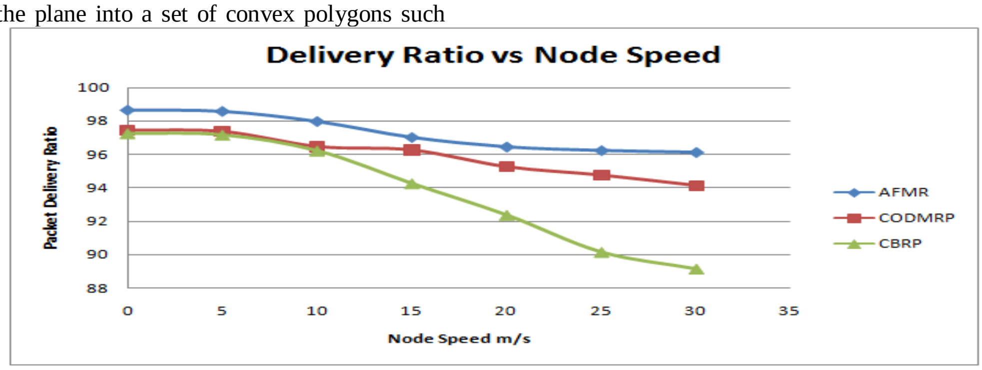

Fig 2 Packet Delivery Ratio

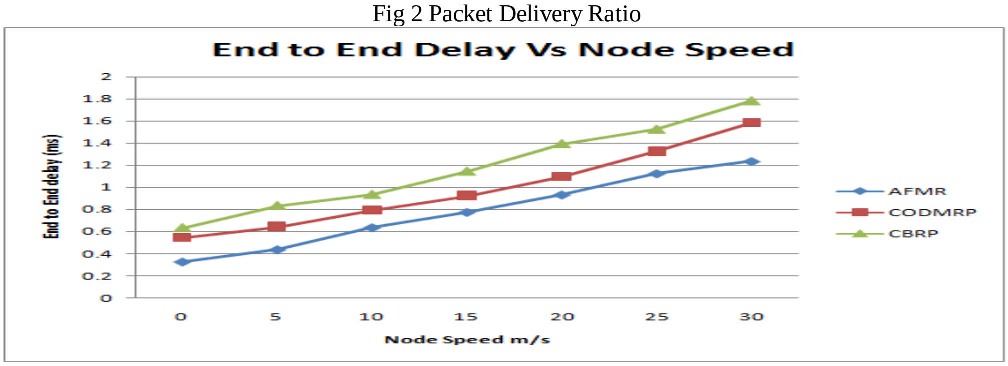

Fig 3 Average End to End Delay (ms)

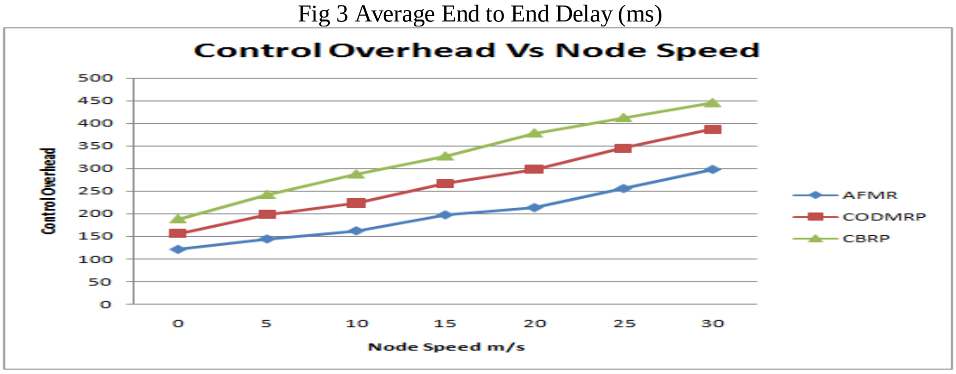

Fig 4 Control Overhead (ms)

3.3.3 Location Updates in Clustered Groups

By using kalman filter we can predict the location updates within clustered groups, each CH gets their neighbors locations.CH also exchange their position to members.CH keeps tracks of nodes position it will leads to predicts the new cluster head based on mobility.CH also predict neighbors' future directions. It will leads to fuzzy membership function, here it reduces re-clustering timing.

3.3.4 CH to CH Groups

Cluster head to cluster head scenario location management scheme updating position of neighbors' nodes will exchange each other. Like if any node moving out of clustered groups.CH will predict the future direction and exchange to direction based CH.While applying the new CH selection this information will leads efficient fuzzy membership formation. In networks with mobile nodes and multiple recipients, however, it depends on the ability of location management schemes to efficiently provide relevant nodes with the position of mobile nodes at any time. Each member will thus expect to receive location updates from the actor it is dominated by. With respect to delay, the energy consumption for location updates is drastically reduced.

4. PERFORMANCE EVALUATION

To evaluate the performance of AFS, we simulate the fuzzy clustering in a variety of mobile network topologies in NS-2 [18] and compare it with CODMRP [4] and CBRP [5].

As far as multicast communication is concerned, implement the clustering and location management scheme described in Section 3. The MAC layer is based on IEEE 802.11. The monitored area is a 500 m 500 m square, with 50 randomly deployed nodes similar to that used in the previous experiments, but all the nodes move according to the RWP model. The maximum transmission range of nodes is set to 50 m and the bandwidth to 250 Kbit/s. We perform terminating simulations that last 150s, average over different random topologies. The mobility experiment consisted of 5 traffic sources and 20 receivers chosen randomly. Each source transmitted 10 Kbps and thus the overall network load was 50 Kbps. The minimum node speed is 1 m/s and we vary the maximum speed to change the mobility of the network.

4.1 Metrics

We use the following metrics in evaluating the performance of the different multicast routing protocols. The following metrics are used for network performance comparison:

- Packet delivery ratio. The ratio of the n umber of data packets received at the destination(s) to the number of data packets sent by the source(s).
- End-to-end delay. The average and the median end-to-end delay are evaluated, together with the cumulative distribution function of the delay.
- Control overhead. The control overhead in a clustered routing scheme can be due to packet transmissions per node, due to the maintenance of routing tables as well as due to the address management or location management.

Fig. 2 highlights the effectiveness of the delivery in the air utilized by AFMR. Even when the maximum node speed increases to 30 m/s, AFMR still enables nearly 99 percent of the packets to reach the destination while the delivery ratios of CODMRP and CBRP both decrease significantly. We notice that at lower speeds the difference in packet delivery ratio is between5% and 7%.However,at higher speeds the gap in packet delivery ratio starts widening.

From Fig 3, we can see that AFMR is not only effective but also efficient. It delivers as many as possible packets at extremely low delay.

The near cluster optimum path length contributes to the efficiency. On the other hand, the mitigation of prediction of future cluster head collaboration reduces the end-to-end delay significantly with comparing of CODMRP and CBRP.

As for the overhead, Figs.4 show that AFMR excellent performance is not at the cost of increased re-clustering. Note that AFMR overhead does not change with mobility as only data header packets contribute to overhead. In the context of infrastructure networks, by using opportunistic fuzzy clustering on overhearing, the connectivity between the mobile node and cluster head (CH) can be significantly improved.

5. CONCLUSIONS

In this paper, we address the problem of reliable multicast data delivery in highly dynamic mobile ad hoc networks. Constantly changing network topology makes conventional ad hoc routing protocols incapable of providing satisfactory performance. We reported on simulation-based experiments evaluating our proposed approaches fuzzy clustering to multicast communication in mobile ad hoc networks (MANETs), namely AFMR and comparing with existing protocols namely CODMRP and CBRP. One of the chief contributions of this work is our objective analysis of these multicast routing protocols categories in order to characterize their behavior under a wide range of MANET mobility. We present a cluster head election scheme using fuzzy logic system for mobile ad hoc wireless networks. Three descriptors are used its remaining battery capacity, and its degree of mobility. In this approach nodes can dynamically switch routing mechanisms based on their perception of the network conditions. Kalman filter used to predict the future clusters and cluster heads, its increasing the performance of clustering phases and reduce the re clustering delay and control packets. The efficiency of the involvement of future cluster head prediction against node mobility, as well as the overhead due to fuzzy clustering is analyzed. Through simulation, we further confirm the effectiveness and efficiency of AFMR: high packet delivery ratio is achieved while the delay and overhead are the lowest. The future direction is focus on enhancing fuzzy clusters with different parameters due to delay in large scale networks.

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