Presenting a multicast routing protocol for enhanced efficiency in mobile ad-hoc networks

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Abstract

The Mobile Ad-hoc Networks consist of wireless mobile nodes without any pre-determined structure of the network. Routing in this network include important challenges such as changes topology, energy, density of traffic. Due to the limitation of the network resources, multicast routing is an effective method to reduce the network resource consumption. Because Send a copy of the same data to multiple destinations in multiple broadcast method is better than data transmission using a single broadcast to each of the target groups. Due of the lack of a fixed infrastructure in these networks and due to lack of pre-defined physical backbone, a virtual backbone can be formed.

Topics proposed algorithms in multicast mesh and tree-based holding virtual backbone, has created a way to send multicast message And proceeded to send a multicast to the group. Some of This paper examines the ability of learning automata model to solve the routing problem and increase the network lifetime by using energy parameters and mobility. In proposed method first build connected dominating set (CDS) as a virtual backbone, based on learning automata which this backbone is created based on energy and link stability. In continue proposed algorithm is compared with several protocols, such as ODMRP and MAODV-based broadcast and the delay time which the results show the superiority of this protocol is compared to other protocols.

Key words: MANET, Multicasting, Learning Automata, Power Management.

1. Introduction

A mobile Ad-hoc networks (MANET) is a self-organizing multi-hop wireless network, which can be instantly developed in situations where either fixed infrastructure is unavailable (e.g., disaster recovery), or a fixed infrastructure is difficult to install (e.g., battlefields)[3]. These networks include wireless nodes that without dependence on a centralized control center, participate in the routing process. Multicast routing is an effective way to establish the group communications in which the messages need to be sent from a transmitting node to multiple receivers. In a wireless network, due to the broadcast nature of the omnidirectional antennas, a single transmission can be received by all neighbors of the transmitting node [1].

Therefore, the multicast routing protocols designed for the traditional wired networks are not applicable to the wireless networks. In a wired network, the multicast packets are forwarded along the tree edges, and so the multicast routing problem can be defined as a Steiner tree problem where the multicast group members are the terminals (leaf nodes) in the Steiner tree. On the other side, in wireless Ad-hoc networks, owing to the broadcast nature of the wireless channels, the Steiner connected dominating set (SCDS) [3] is a promising approach for modeling the multicast routing problem, where the multicast group members must be dominated only. The Steiner connected dominating set constructs a virtual multicast backbone (VMB) which significantly reduces the routing overhead compared to the notorious flooding mechanism as the number of hosts responsible for rebroadcasting is reduced to the number of hosts in backbone [٤].

One of the important challenges in the ad-hoc network is link stability. In this paper, we propose a distributed learning automata-based algorithm to solve the multicast routing problem in wireless mobile Ad-hoc networks. The proposed multicast routing algorithm aims at alleviating above mentioned problems.

The rest of the paper is organized as follows. The next section provides an overview of multicast protocols. The proposed multicast routing algorithm is described in Section 3. The problem statement is given in Section 4. In Section 5 describe network model. Finally in sections 6, 7 describe performance evaluation and Conclusions and future works.

2- Related works

Multicast routing protocol is used to send a packet to multiple destinations. Mobile ad hoc network routing is a difficult problem because network characteristics such as traffic load and network topology may vary stochastically and in a time varying nature [8]. Multicast routing protocol can be classified into two categories based on how routes are created to the members of the group.

The first is known as tree based approach, there is only one path between a sources receiver pair and the union of the paths from the source to the receivers forms the multicast tree. This is done using either source-base trees or shared trees. In source- based trees, single multicast tree is maintained per source, while in shared trees a signal tree is shared by all the sources in the multicast group. Tree- based protocols provide high data forwarding efficiency and low overhead but it is not robust in high mobile environments.

The second approach is mesh-based, where may be multiple paths between senders and receivers. This redundancy provides robustness against topological changes better than tree based protocols [5].

The Multicast operation of Ad-hoc On-demand Distance Vector (MAODV) routing protocol is a hard state reactive tree based routing and it discovers multicast routes on demand using a broadcast route- discovery mechanism [8]. A mobile node originates a route request (RREQ) message when it wishes to join a multicast group. Only a member of the desired multicast group may respond to a join RREQ. If an intermediate node receives a join RREQ for a

multicast group of which it is not a member, or if it receives a RREQ and it does not have a route to that group, it rebroadcast the RREQ to its neighbors. As the RREQ is broadcast across the network, nodes set up pointers to establish the reverse route in their route tables. The responding node updates its route and multicast route tables by placing the requesting node's next-hop information in the tables, and then unicasts a request response RREP back to S [8].

The On-Demand Multicast Routing Protocol (ODMRP) is a soft state reactive mesh based and uses a forwarding group concept i.e. only a subset of nodes forwards the multicast packets. In ODMRP multicast group members are maintaining as soft state approach, No explicit control message is required to leave the group, and group membership and multicast routes are established and updated by the source on demand.

The reactive MAODV and ODMRP are having certain salient characteristics in multicast routing protocol environment. Principally, both protocols discover multicast routes only in the presence of data packets to be delivered to a multicast destination. Similarly both are having significant differences by the following ways; First, MAODV uses a shared bi-directional multicast tree while ODMRP maintains a mesh topology rooted from each source. In MAODV, the tree is based on hard state and any link breakages force actions to repair the tree.

3-Multicasting protocol with LET [1]

Learning automata is an abstract model with limited number of action and probability of choosing action. Each chosen action is evaluated by a stochastic environment and a response is sent back to the environment. Learning automata uses this response to choose an action for its next level.

Here, we explained the proposed algorithm that we called LET. The use of virtual backbone in MANET is very important. The set of nodes groups in the form the collection Dominator set.

In this method, each mobile host immediately broadcasts activation packet to its neighboring nodes the root automaton randomly chooses an neighbor according to its action probabilities and add to Dominator Set. In this method, a subset of nodes is chosen as dominators to construct a route from the sender to each of the multicast receivers. In such networks, the broadcast routing problem corresponds to a connected dominating set problem in which the dominators form a virtual backbone for transmission of the broadcast messages to the entire network. The dominating set problems are a class of the optimization problems which are widely used in wireless Ad hoc networks. With the completion of the route by algorithm, A MULTICAST message includes the multicast routes e is broadcasted through the network.

4-Description problem

In general a service selection strategy is based on certain criteria or metrics. These metrics can be either route (e.g. hop-count, band width, delay) or service (e.g. server mobility, load, remaining energy and capacity) specific.

Stability method in this paper for route selection and increasing performance is introduced. A good design of the ad hoc routing protocol is needed to overcome the problem. It aims to strike the balance between parameters.

4-1 Link Stability

1Link Expiration Time

Topology of a mobile ad hoc network will often change rapidly and power nodes finish soon. We used learning automata for selection best route between available routes. For path discovery, route with shortest and highest energy is selected in path.

4.2 Learning Automat and stability rule

In a learning automata system, when a specific action is performed, the random environment provides either a favorable or an unfavorable feedback [6]. The objective in the design of the learning automaton is to determine how the previous actions and responses should affect the choice of the current action to be taken. Automaton learns from the feedback provided by the random environment and it takes decisions based on the knowledge provided by the random environment. At any stage, the choice of action could be either deterministic or stochastic.
A learning automaton can be formally precisely and described in terms of the following:
$E \equiv \{\alpha, \beta, C\}$ Output : $\{\beta_1, \beta_2, \dots \dots \dots, \beta_r\}$ $\beta \equiv$ {Input: $\alpha \equiv \{\alpha_1, \alpha_2, \dots, \alpha_r\}$
Reward: $c=\{c_1, c_2, \dots, c_r\}$
After executing action, automata will immediately receive reward and based on that probability vector will be updated [3].

4.3. Degree of link stability

Proposed algorithm in [3], a formula is proposed to find the relative speed of the nodes.
The concept of the relative mobility is defined so as to characterize the mobility degree a mobile host exhibits with respect to its neighboring hosts. A host with a higher mobility degree is more prone to the unstable behaviors than a host with less mobility degree, and so the proposed multicast routing algorithm attempts to select the hosts with less relative mobility for constituting the multicast routes.
To compute the relative mobility, the mobility profile of each host must be exchanged with its neighboring hosts. Since the mobility characteristics (speed and direction) of a mobile host vary with time, the host relative mobility is a random variable and may also change as the host moves. Therefore, the relative mobility of a host must be periodically reevaluated for adaptation to the future states of the network. The criterion upon which the proposed mobility-based multicast routing algorithm is based enables the algorithm to find the more stable routes from the multicast source to the receivers. In proposed algorithm instead of mobility, stability is considered. Thus function LET denote by equal 1

(۱)

$$LET=\frac{-(ab+ad)+\sqrt{(a^2-c^2)r^2-(ad-cd)^2}}{(a^2+c^2)}$$

$a=V_i \cos \theta_i - V_j \cos \theta_j$, $b=x_i - x_j$

$c=V_i \sin \theta_i - V_j \sin \theta_j$, $d=y_i - y_j$

Our approach to learning a scheduling policy $\Pi(s)$ is based on the standard reinforcement learning. Let us begin by describing the general goal of learning in this context. Consider the system at time t in state set the scheduler selects an action at and in turn receives a reward rt+1.

5. Network Model

GLomosim program is used to realize the simulation of the algorithm. For our results we assumed average velocity of 150 mobile nodes communicating. The nodes move inside a simulation area of 2000m*200m.

6. Performance Evaluation

A new routing algorithm should show its performance in comparison with existing and known algorithms. We evaluate mainly the performance according to the metrics packet delivery ratio, overhead and delay.

Measure of receive packet at node i calculated in formula 2 and overhead measure in formula3

$$\text{pdr} = \frac{\sum Recive\ packets}{\sum Send\ Packet} \quad (۲)$$

$$\text{overhead} = \frac{\sum Recive\ packet}{\sum CTR\ packets} \quad (۳)$$

We present a simulation scenario to study thoroughly the proposed scheduling solution.

Fig 1 shows the mobility and delay. We verify that the RL scheduler provides a decrease in the latency.

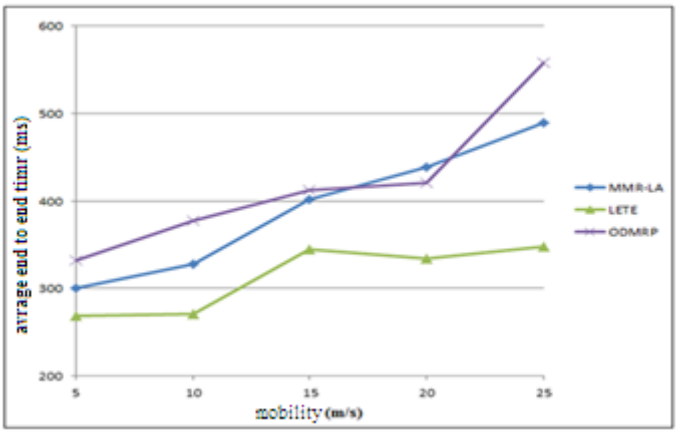

Fig 1 :.Average Delay.

Because AODV uses particular route, over time this will destroy the path and find a new path will lead to delay. But in the proposed protocol does not caused a problem because use of different routes.

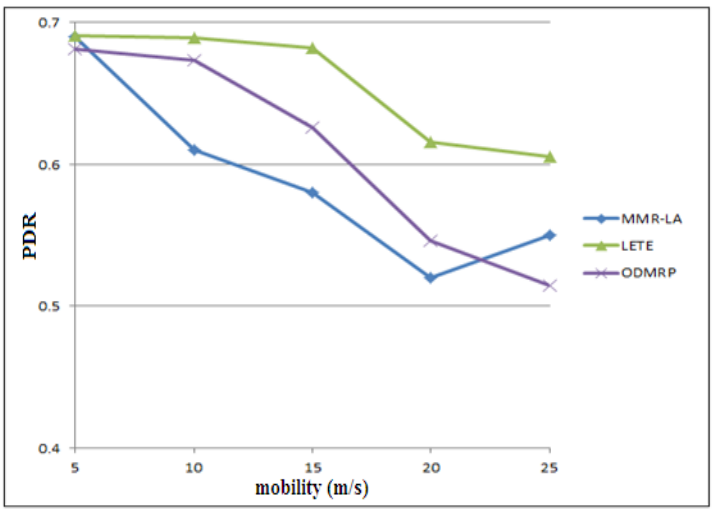

Fig 2: Packet delivery ratio.

Overload concept of in network at node i is received to send data. Figure 3 shows the overhead of LETE. All results are very close through all simulation scenarios. This shows that LETE creates much less routing overhead for all considered mobility scenarios.

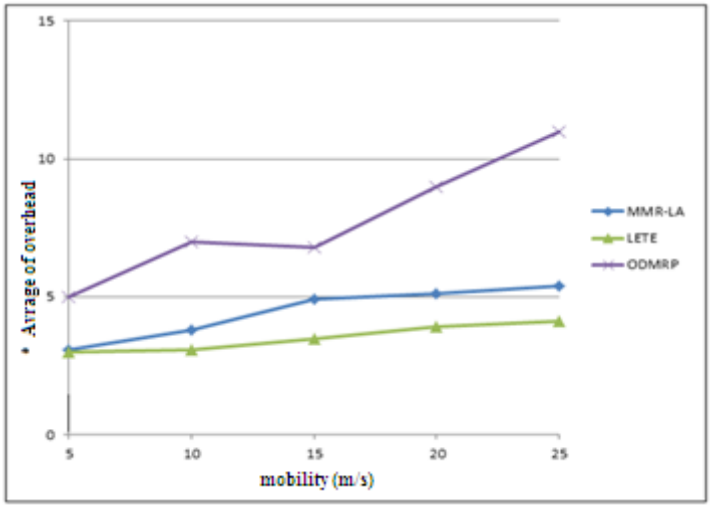

Fig 3: Average of overhead.

We have carried out other simulations to verify the correctness of the proposed analytical model for the LETE algorithm and to compare its performance with other algorithms, under a broad set of simulation parameters.
We assumed maximal velocity of 300 mobile nodes communicating and time simulation high. The simulation results have clearly shown that LETE algorithm not so good.

7. Conclusions and future works

In this article, the behavior of some algorithms and the proposed algorithm based on the delay parameters and simulation were compared. Algorithm proposed has the best results. RL schemes can adapt to changing traffic statistics and QoS requirements. Simulation results show that the proposed Scheduler find the best solution for low velocity of mobile nodes.
Use of learning automata let to unique management.
For optimization this algorithm can use of clustering method for decrease overhead or applied SNR parameter in LET formula.

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