A Study On STMRP And MMR-LA Multicast Routing Protocols In Mobile Ad Hoc Networks

S.V.Evangelin Sonia, S.Dhivya
Assistant Professor, Department of computer science and Engineering
Sri Shakthi Institute of Engineering and Technology

***Abstract* - MANET is a distributed wireless network which is suitable for multitasking due to its characteristics such as free mobility, self-configuration, and fast deployment. Most of the existing multicast routing protocols in MANETs support only single source multicasting and become inefficient for multi-source multi-casting. Also the mobility characteristics of each node are assumed to be constant, and so they do not scale well when the mobility parameters are stochastic and unknown. These problems in MANETs are overcome by two protocols namely, STMRP and MMR-LA. STMRP supports efficient multicasting in the multi- source environment and MMR-LA performs mobility-based efficient multicasting. In this paper, these two protocols have been studied and a comparative analysis on these two protocols has been made. The performance of these protocols has been compared in terms of packet delivery ratio, multicast route lifetime, and end-to-end delay. The performance results show that MMR-LA is more efficient than STMRP.**

***Keywords*-- mobile ad hoc networks, multicast routing, mobility.**

---

1. INTRODUCTION

Multicasting supports a variety of applications and services in an efficient manner. Multicasting is the process of delivering a message to a group of nodes in a network. The message may come from a single source or from a group of sources. Multicast routing is an effective way to establish group communications in which the messages need to be sent from a transmitting node to multiple receivers. Multicast routing protocols are essential for many applications and services such as video streaming,

distance learning, group communication, news/file distribution, and video/audio on-demand. A MANET is a self-organizing and self-configuring multi-hop wireless network, which can be instantly developed in situations where either a fixed infrastructure is difficult to install (e.g., battlefields), or a fixed infrastructure is unavailable (e.g., disaster recovery). Multicast routing protocols can be classified into two categories: tree-based or mesh-based approaches. The tree topology is commonly used for multicasting in the wired network. Multicast efficiency can be easily achieved by a tree-based approach, since there is only one route between a pair of source and receiver. In MANETs, the topology changes may lead to frequent multicast tree reconfiguration, thus incurring excess control overhead and losing performance. Contrary to tree-based approaches, the structure used by mesh-based approaches provides multiple routes from a source to a receiver. By taking advantages of alternative routes, mesh-based multicast protocols address the issues of reliability and robustness. Several researches show that mesh-based protocols seem to outperform tree-based approaches under a mobile environment. However, route redundancy of mesh-based proposals results in low multicast efficiency as well as increased network load, especially when the multicast group consists of many sources and receivers.

Most of the existing multicast routing protocols support only single source multicasting in a multicast environment and become inefficient for multi-source multicasting. To solve this problem, STMRP [1] was introduced. Also in a multicast environment, multicast routing is efficiently done if the node are static and become inefficient when the node in the multicast group become mobile. To solve this problem, MMR-LA [2] was introduced. In STMRP a multiple shared-trees with multiple sources is first constructed and then multicast forwarding is done on those multiple shared trees. The shared-tree [14] is constructed based on ODMRP [5] protocol. The cost to construct multi-source [3] shared-tree is lower than individual single-source multicasting tree. In MRP-LA estimates the relative mobility of each host to predict its motion behavior and creates a virtual multicast backbone. The relative mobility [7] is estimated using Learning Automata Technique [10][11]. Thus instead of measuring the mobility of single source multicast node, the mobility of multi-source multicast nodes is measured by considering the movement parameters as random or stochastic variables [12][13]. These protocols preserve multicast efficiency and robustness. This mobility prediction method is capable of estimating the long-term motion behavior of the host, and so finds the more stable routes that stay connected for a longer time. In this paper, these two protocols have been studied and their efficiency is compared in terms of packet delivery ratio, multicast route lifetime and end-to-end delay.

2. SHARED-TREE-BASED MULTI-SOURCE MULTICAST ROUTING PROTOCOL

The SMMRP [1] is a protocol for the multi-source multicasting in MANETs based on the multiple shared trees. The root of the shared tree is one of the source nodes and it is called core.

2.1 Multicast Delivery on a Single Shared-tree

In this paper an algorithm is used which dynamically decides the root node (core) which tries to construct the compact shared-tree. It is assumed that a certain specific node A operates as a core node as in fig.1. This core node flood Join-Query at first to all the multicast group nodes in the tree just like ODMRP protocol. The multicast receiver sends back Join-Reply to the node from which it receives Join-Query earliest. The delivery tree is constructed by this communication, that the core node is a root of the tree. The nodes in the tree identify the multicast routing table by the core node ID. The core node calculates *Ha* the average number of hops to all receivers.

Next, the core node inquires the possibility to entrust with the core function to the node P which is located in the middle point of the path to the furthest receiver. P composes a temporary tree from P by flooding Pre-Join-Query, and the receipt of Pre-Join-Reply from the multicast receiver. Then, P calculates Hp number of average hops at that time. Node P responds to node A to entrust the core function when,

Hp is smaller than Ha

Node A tells to the multicast group member that P has become a core according to the Change-Core message. P is newly moved to the middle point with A when

Hp is larger than Ha

and the same above procedure are repeated. Moreover, it is necessary to restructure this shared-tree regularly in consideration of the movement of the nodes.

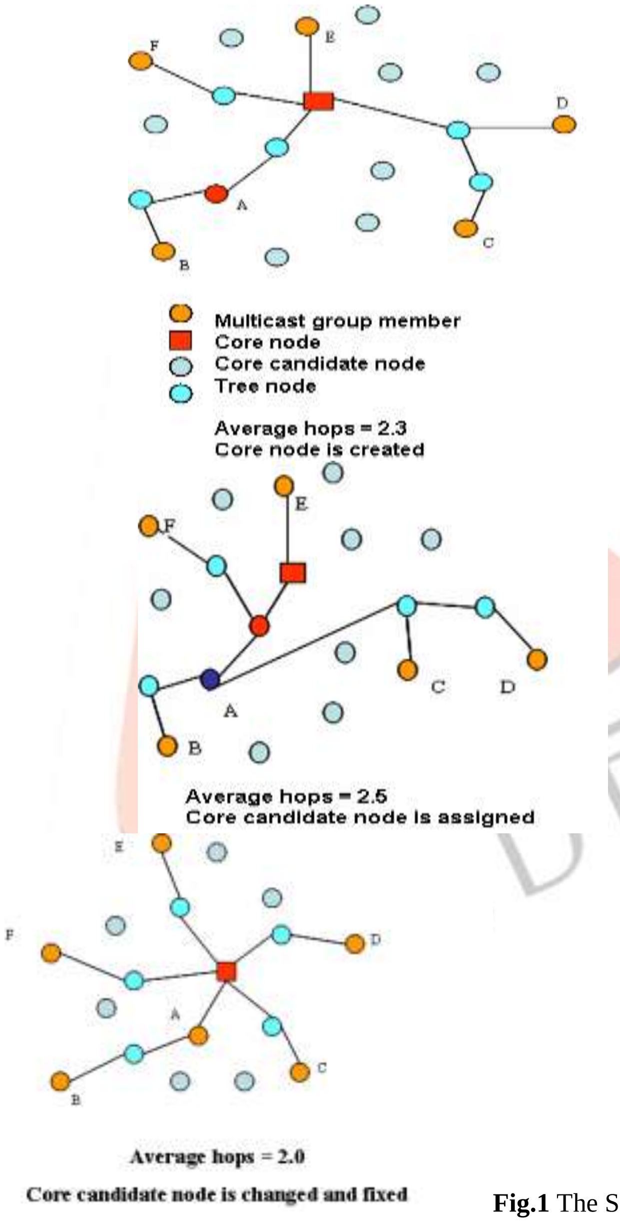

Fig.1 The STMRP procedure

After constructing a shared tree, multicast delivery is done on the shared-tree to multicast the information to the group members. When the multicast group member transmits the multicast data, the core node ID is set as the destination of the multicast packet and the routing is done by the routing table identified by the core node ID. When the node which belongs to the delivery tree receives the multicast packet, if it is not an end node of the tree and the packet hasn't be seen, the packet must be retransmitted to the tree. Therefore, there is no fixed directionality in the delivery of the multicast packet. If the destination of the packet is not known by receiver, it does not transmit. When the multicast packet transmitted once is received, it does not transmit again.

2.2 Multicast Delivery on Multiple Shared-trees

To construct two or more multicast shared trees, two or more core nodes are prepared. However, there is a problem that cores gather in the same position in the algorithm to be able to do a compact tree as much as possible even if two or more core nodes are used. Then, the appropriate distance (hops) between cores is taken into account when the core and the core candidate node compute the number of average hops by the flooding of Join-Query and Pre-Join-Query. If a core receives Join-Query or Pre-

Join-Query from other core, it informs the distance (hops) from the core by using Join-Reply or Pre-Join-Reply. If the distance from other cores is Hx and the threshold of the appropriate distance between cores is assumed to be Hth,
| Hth-Hx |
is added to the number of average hops of trees. Thus, it is possible to construct the multiple compact trees that the core does not overlap.

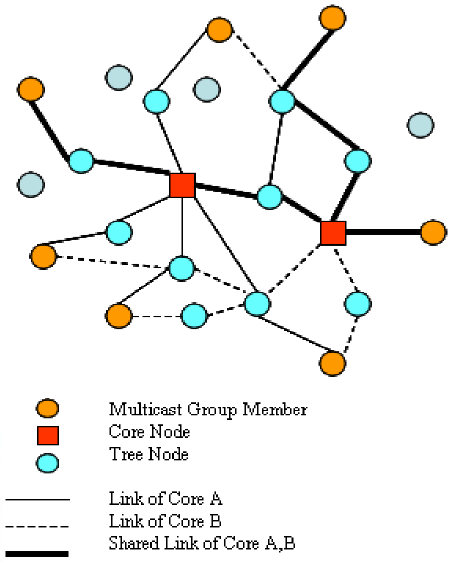

Fig. 2 Multiple shared-trees

After constructing a multiple shared trees, multicast delivery is done on the multiple shared-trees to multicast the information to multiple group members. A strong delivery can be achieved by using two or more shared-trees even if the tree is dividing into parts. Data is transmitted specifying two or more delivery trees that the sender belongs when the participant of the multicast delivery tree transmits data. Two or more core nodes ID are used for the specification of the delivery tree.

The node which received the multicast packet investigates the specified core node ID. If the ID is one of the any trees that the receiver belongs, and if the node is not end of the tree, the packet retransmits. The multicast packet retransmitted once is not transmitted again. If some of the trees are divided to some parts, multicast packets can be transmitted by the connected tree. By this method, a reliable multicast delivery becomes possible.

3. THE MOBILITY-BASED MULTICAST ROUTING ALGORITHM

A distributed learning automata-based multicast routing algorithm called MMR-LA is proposed for wireless mobile Ad-hoc networks. In this approach, each host (e.g., hi) is equipped by a learning automaton (e.g., Ai) whose learning algorithm is a linear reward-inaction. The resulting network of learning automata is isomorphic to the network graph and can be described by a triple $< A, \alpha, w >$ where $A = \{A1, A2, ..., AN\}$ denotes the set of the learning automata corresponding to the vertex-set (or the set of hosts), $\alpha = \{\alpha1, \alpha2, ..., \alpha3\}$ denotes the set of actions such that $\alpha1 = \{\alpha ij\}$ where hj is a neighbor of hi and W = {w1, w2,……wn} denotes the set of weights such that $wi(\forall i \in \{1, ..., n\})$ is the random weight associated with automaton Ai.

3.1 Learning automata activation process

When a given host hi receives an ACTIVATION message, it inserts its ID as a new dominator host into the DOMINATOR_SET. To update the DOMINATEE_SET it adds its ID and its one-hop neighbors’ ID to this set. The relative speed (or weight) of the activated host is added to the set W. The action-set of learning automaton Ai is updated by disabling some actions. Now, if there exist some actions to be chosen by learning automaton Ai and the DOMINATEE_SET does not include all the multicast group members, learning automaton Ai is activated to choose one of its actions as a new dominator host, and updates its probability vector by adding the probability of choosing the action, and sends an ACTIVATION message to the chosen dominator host. To verify the stopping condition of the multicast routing process, the probability of choosing the recently selected DOMINATOR_SET is computed. This probability is defined as the product of the probability of choosing the dominator hosts contained in the DOMINATOR_SET. If this probability is greater than the certain threshold, dominator host hi declares the new multicast route by sending a message including the last selected DOMINATOR_SET within the network. By receiving this message, each network host is noticed that the multicast routing process has been completed, and it thereafter uses the new multicast routes to send the multicast packets to the given multicast members. When the stopping condition is false, the average relative speed of the chosen DOMINATOR_SET (multicast route) is calculated and inserted in the DOM_SET_VCT. If the average weight of the selected DOMINATOR_SET is less than the dynamic threshold TRSHLD, and all the multicast members are dominated by the selected DOMINATOR_SET, all the chosen actions of the activated automata (corresponding to the dominator hosts) are rewarded, otherwise, they are penalized. As the algorithm proceeds, the average relative speed of each DOMINATOR_SET (multicast route) tends to its actual value, and so the probability of rewarding the more stable routes increases as the probability of penalizing the unstable routes increases. Finally, the probability of choosing the multicast route with the minimum expected relative speed (i.e., the most stable multicast route) converges to one.

4. SIMULATIONS AND PERFORMANCE ANALYSIS

We compare the performance of STMRP and MMR-LA using OMNETpp simulator version 4.0 [16]. The simulation scenario consists of 25 multicast nodes randomly distributed in a 600m × 400m area. The random waypoint model [17] is used to model the mobility of mobile nodes. The moving speed of the mobile nodes is uniformly distributed in 1m to 10 m per second. For multisource simulation, 35% of group members are selected as the multicast source.

The following four performance metrics are used: (1) Packet delivery ratio: the number of data packets delivered to the multicast members over the number of data packets supposed to be received by multicast members (2) End-to-end delay: the time required for multicast route creation as well as the time required for transmitting the multicast packets (3) Multicast route life time: The time interval during which the multicast routes remain connected. (4) Control overhead: total number of control packets and total number of bytes of control information.

- Packet delivery ratio: From fig.3 it is observed that MMR-LA has good packet delivery ratio than STMRP when the multicast group size increases.
- End-to-end delay: From Fig.4 it is observed that MMR-LA sends the multicast packets in a reasonable delay than STMRP.
- Control overhead: From Fig.5 it is observed that the multicast control overhead decreases in MMR-LA than in STMRP when the network size increases.
- Multicast route Lifetime: In MMR-LA, the multicast route life time increases than in STMRP when the multicast group size increases.

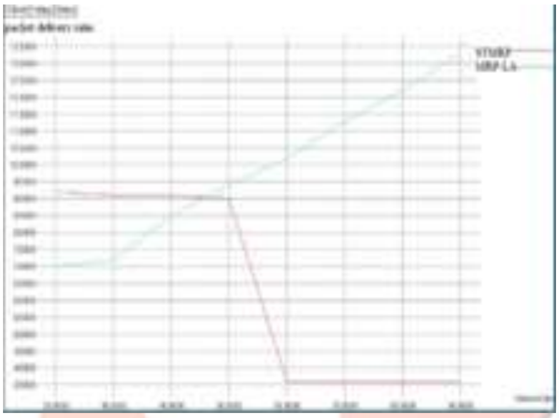

Fig. 3. Packet delivery ratio Vs Network size

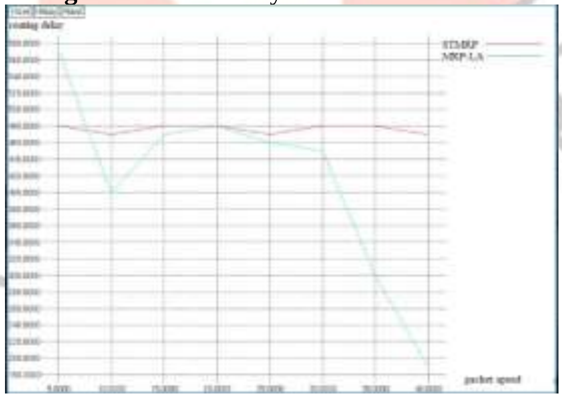

Fig. 4. Routing delay Vs Packet speed.

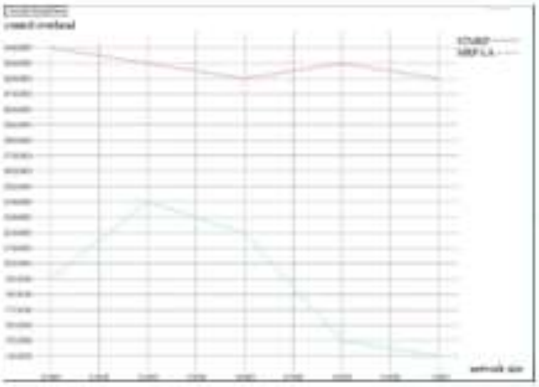

Fig. 5. Multicast control overhead Vs Network size

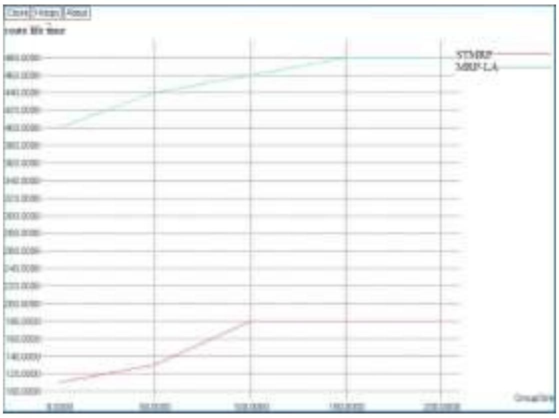

Fig. 6. Multicast route lifetime Vs Multicast group size

5. CONCLUSION

In this paper, a comparative study is made on two protocols namely, a shared-tree-based multicast routing protocol (SMMRP) and mobility-based multicast routing protocol using learning automata (MMR-LA) for multicast routing in MANETs. The analysis results show that MMR-LA has better performance than STMRP in terms of packet delivery ratio, end-to-end delay and communication overhead and multicast route lifetime.

6. FUTURE WORK

The future works includes experimentation on all multicast routing protocols and show their performance in various metrics and to find the similarities between them.

7. ACKNOWLEDGEMENT

The authors are thankful to Dr. P. Suyambu, Chairman, PSN Group of Institutions for his constant support and encouragement.

8. REFERENCES

[1] Fumiaki Sato, "An Efficient Shared-tree-Based Multi-Source Multicast Routing Protocol in Mobile Ad Hoc Networks", in: International Conference on Advanced Information Networking and Application Workshops, 2009.
[2] Javad Akbari Torkesani, Mohammad Reza Meybodi, "Mobility-based Multicast Routing Algorithm for Wireless Mobile Ad-hoc Networks: A Learning automata approach", in: International Journal on Computer Communications vol. 33, pp. 721–735, 2010.
[3] Kang, H. and Lee, M., "A Multi-source Multicast Routing Protocol for Ad-Hoc Networks" in: Revised Papers from the International Conference on Information Networking, Wireless Communications Technologies and Network Applications - Part II , 2002.
[4] E. Royer, C. Perkins, "Multicast operation of the ad-hoc on-demand distance vector routing protocol", in: Proceedings of the 5th Annual ACM/IEEE International Conference on Mobile Computing and Networking (MobiCom '99), pp. 207–218, 1999.
[5] S. H. Bae, S.J. Lee, W. Su, M. Gerla, "The Design, Implementation, and Performance evaluation of the On-demand Multicast Routing Protocol in Multihop Wireless Networks", IEEE Network, vol. 14, pp. 70-77, 2000.
[6] E. M. Royer and C. E. Perkins, "Multicast operation of the ad-hoc on-demand distance vector routing protocol", Proceedings of the 5th annual ACM/IEEE international conference on Mobile computing and networking, 1999.
[7] W. Su, S.J. Lee, M. Gerla, "Mobility Prediction and Routing in Ad-hoc Wireless Networks", International Journal of Network Management, vol. 11, pp. 3–30, 2001.
[8] B. An, S. Papavassiliou, "MHMR: Mobility-based hybrid multicast routing protocol in mobile ad-hoc wireless networks", Wireless Communication and Mobile Computing, vol. 3, pp. 255–270, 2003.
[9] T. Nadeem, S. Parthasarathy, "Mobility control for throughput maximization in ad-hoc networks", Journal on Wireless Communication and Mobile Computing, vol. 6, pp. 951–967, 2006.
[10] K.S. Narendra, K.S. Thathachar, "Learning Automata: An Introduction", Printice-Hall, New York, 1989.
[11] M.A.L. Thathachat, P.S. Sastry, "A hierarchical system of learning automata that can learn the globally optimal path", Journal on Information Science, vol. 42, pp. 743–766 , 1997.
[12] J. Akbari Torkestani, M.R. Meybodi, "Solving the minimum spanning tree problem in stochastic graphs using learning automata", in: Proceedings of International Conference on Information Management and Engineering (ICIME 2009), Kuala Lumpur, Malaysia, pp. 643–647, April 2009.
[13] H. Beigy, M.R. Meybodi, "Utilizing Distributed Learning Automata To Solve Stochastic Shortest Path Problems", International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems, vol. 14, pp. 591–615, 2006.
[14] L. Canourgues, J. Lephay, L. Soyer, A.L. Beylot, "STAMP: Shared-tree Ad-hoc Multicast Protocol", in: IEEE Military Communications Conference (MILCOM 2006), pp. 1–7, 2006.
[15] K.M. Alzoubi, P.J. Wan, O. Frieder, "Maximal Independent Set, Weakly Connected Dominating Set, and Induced Spanners for Mobile Ad-hoc Networks", in: International Journal of Foundations of Computer Science, vol. 14, Issue. 2, pp. 287–303, 2003.