Comparison and Performance Analysis of Proactive and Reactive Multicast Routing Protocols in MANETs

Garima Sharma, Mukhwinder Kaur and Inderjeet khurana
Faculty of Engineering, Department of ECE, RIMT, Mandi Gobindgarh,Punjab.
Email:garimas777@gmail.com

Abstract:

The MANETs is to extend mobility into the realm of autonomous, mobile and wireless domains, where a set of nodes form the network routing infrastructure in an ad-hoc fashion. The majority of applications of MANETs are in areas where rapid deployment and dynamic reconfiguration are necessary and wired network is not available.

In ad-hoc networks, nodes are not familiar with the topology of their networks. Instead, they have to discover it. The basic idea is that a new node may announce its presence and should listen for announcements broadcast by its neighbors. Each node learns about nodes nearby and how to reach them, and may announce that it, too, can reach them.

The Multicast protocol can generally be categories into two: proactive and Reactive i.e On-Demand, DVMRP and PIM-DM . ODMRP is a mesh-based, rather than a conventional tree based, multicast scheme and uses a forwarding group concept. Three prominent multicast routing protocols are selected for performance protocols. The simulation environment Qualnet 5.0.2. The main aim is to calculate the relative feature and quality of each protocol.

Keywords:

DVMRP, ODMRP &PIM-DM Computer Network, Routing Protocols, Path loss Models

I. Introduction

In this Paper represents the Internet Group Management Protocol (IGMP) runs among hosts and their immediately neighboring multicast routers. The mechanisms of the protocol provide a host to inform its local router that it wishes to obtain transmissions addressed to a specific multicast group. Also, routers periodically query the LAN to determine if acknowledged group members are still active. If there is more than one router on the LAN performing IP multicasting, one of the routers is elected "querier" and acquires the responsibility of querying the LAN for group members. Based on the group membership information determined from the IGMP, a router is able to determine which (if any) multicast traffic needs to be forwarded to each of its "leaf" sub networks. Multicast routers use this information, in conjunction with a multicast

routing protocol, to support IP multicasting across the Internet [1].

In this Paper authors MOSPF is an expansion of the unicast routing protocol OSPF. OSPF is a link-state routing protocol in which the routers advertise the state of their directly attached links, and based on these advertisements, each router builds up a link- state database. The OSPF link-state database provides a complete picture of the topology of an Autonomous System (AS). In order to support multicast routing, a new type of link-state advertisement, referred to as the group-membership-LSA (Link State Advertisement), has been added to OSPF. These advertisements help to pinpoint the locations of all multicast group members in the database. The path of a multicast data packet can then be calculated by building a shortest-path tree rooted at the source of the data packet. Note that each router in the domain has the complete description of the topology and the membership information, and each one of them uses exactly the same algorithm to computer the shortest-path tree rooted at the same node. Thus every router ends up computing the same tree and creating the corresponding forwarding entries for each group. The shortest path trees are built on demand (that is, when the first packet arrives), and the results of this computation are cached for use by subsequent packets having the same source and destination [2] In this paper, authors investigate the performance of multicast routing protocols in wireless mobile ad hoc networks. An ad hoc network is composed of mobile nodes without the presence of a wired support infrastructure. In this environment, routing/multicasting protocols are faced with the challenge of producing multihop routes under host mobility and bandwidth constraints. In this study, they simulate a set of representative wireless ad hoc multicast protocols and evaluate them in various network scenarios. [3], In this paper the authors have proposed and evaluated the on-demand multicasting routing mechanism for ad hoc wireless network. This mechanism is a generalization of their previously proposed stability-based unicast routing scheme that relies on determining link stability and path stability in order to find out a stable route from a source to a destination. The proposed multicast routing mechanism depends only on local state information (at source) for constructing a multicast tree. [4], In this paper, authors describe that a number of different routing protocols proposed for use in multi-hop wireless ad hoc networks are based in whole or in part on what can be described as on-demand behavior. By on demand behavior, they mean approaches based only on reaction to the offered traffic being handled by the routing protocol. In this paper, they analyze the use of on-demand behavior in such protocols, focusing on its effect on the routing protocol's forwarding latency, overhead cost, and route caching correctness, drawing examples from detailed simulation of the dynamic source routing (DSR) protocol. [5],

In this paper, authors describe a comparative performance of three multicast protocols for Mobile Ad hoc Networks – ODMRP, AMRIS and MAODV focusing on the effects of changes such as the increasing number of receivers or sources and enhancing the number of nodes. Although some simulation results of MANET protocols have been released before, these three protocols

have not been equated in isolation. In recent years, a number of new multicast protocols have been advised for ad hoc networks. A systematic presentment evaluation of these protocols is done by executing certain pretending under NS-2. AMRIS was effectual in a light traffic environment with no mobility, but its execution was capable to traffic load and mobility. ODMRP was very effectual and efficient in most of our simulation scenarios. However, the protocol showed a trend of rapidly enhancing overhead as the number of senders raised.[6] ,In this paper, authors describe an important issue in reliable multicasting in ad hoc networks that is busty packet loss that arises .when a link breaks due to node mobility. In On Demand Multicast Routing Protocol (ODMRP), the source periodically initiates a mechanism for multicast tree creation, through Join Queries. The scheme has been simulated on Global Mobile Simulator (GloMoSim), and has shown to be effective in removing the busty data losses due to link failures. [7], In this paper authors presents,On-Demand Multicast Routing Protocol for mobile ad hoc networks. ODMRP is a mesh-based, rather than conventional tree based, multicast scheme and uses a forwarding group concept [only a subset of nodes forwards the multicast packets via scoped flooding). It applies on-demand procedures to dynamically build routes and maintain multicast group membership. They also describe their implementation of the protocol in a real laptop test bed. They have studied the performance of ODMRP and DVMRP in a real ad hoc network test bed with four network hosts. From their experiments, they discovered that DVMRP suffered from high channel overhead due to control message loss in the wireless channel. Their study showed that ODMRP is more suitable in a multi hop ad hoc wireless environment than DVMRP. [8], In this paper authors describe an Ad hoc wireless networks are self-organizing, dynamic topology networks formed by a collection of mobile nodes through radio links. Minimal configuration, absence of infrastructure, and quick deployment, make them convenient for emergency situations other than military applications. In this paper, they have proposed an efficient multicast routing protocol for Ad hoc wireless networks.The major advantage of this protocol is its increased scalability. This can be mainly attributed to the reduced control overhead. They implemented DCMP using GlomoSim and the simulation results show that there is a 30% reduction in control overhead, while the multicast efficiency is increased by 10-15%, at the cost of a small (2%) reduction in packet delivery ratio for light network loads. They have also found that the packet delivery ratio is improved at high load. [9],In this paper authors propose a novel location management scheme tailored for multicasting in Mobile Ad-hoc Networks (MANETs). They furthermore propose AMDLM, location-based multicast algorithm relying on the location management service. Such an approach avoids fragile data structures such as trees or DAGs to manage multicast groups, without reverting to more reliable, yet overhead-prone mesh-based algorithms. AMDLM additionally enables us to derive analytical bounds due to its location-based nature. [10] ,In this paper authors have presented that a new MAC protocol called RMAC that

supports reliable multicast for wireless ad hoc networks. By utilizing the busy tone mechanism to realize multicast reliability, RMAC has the following three novelties: (1) it uses a variable-length control frame to stipulate an order for the receivers to respond, such that the problem of feedback collision is solved; (2) it extends the traditional usage of busy tone for preventing data frame collisions into the multicast scenario; and (3) it introduces a new usage of busy tone for acknowledging data frames. In addition, they also generalize RMAC into a comprehensive MAC protocol that provides both reliable and unreliable services for all the three modes of communications: unicast, multicast, and broadcast. Their evaluation shows that RMAC achieves high reliability with very limited overhead. [11]. In this paper, authors investigate about the issues of QoS multicast routing in wireless ad hoc networks. Due to limited bandwidth of a wireless node, a QoS multicast call could often be blocked if there does not be a single multicast tree that has the requested bandwidth, even though there is enough bandwidth in the system to hold the call. In this paper, they propose a new multicast routing scheme by using multiple paths or multiple trees to meet the bandwidth requirement of a call. Three multicast routing strategies are studied, SPT (shortest path tree) based multiple-paths (SPTM), and least cost tree based multiple-paths (LCTM) and multiple least cost trees (MLCT). The final routing tree(s) can meet the user's QoS requirements such that the delay from the source to any destination node shall not go beyond the required bound and the aggregate bandwidth of

the paths or trees shall meet the bandwidth requirement of the call. The simulation results show that the new scheme improves the call success ratio and makes a improved use of network resources. Simulation results have demonstrated the effectiveness of their method in reducing the network blockings.[12] In this paper authors have presented that the multicasting is effective when its group members are sparse and the speed is low. They propose an ant agent based adaptive, multicast protocol that exploits group members 'desire to simplify multicast routing and invoke broadcast operations in appropriate localized regimes. By reducing the number of group members that take part in the construction of the multicast structure and by allowing robustness to mobility by executing broadcasts in densely clustered local regions, the proposed protocol achieves packet delivery statistics that are corresponding to that with a pure multicast protocol but with importantly lower overheads. By their simulation results, they show that their proposed protocol achieves increased Packet Delivery Fraction (PDF) with reduced overhead and routing load [13] .In this paper authors have presented that due to dynamism and frequent topology changes a design of a suitable routing protocol is difficult for mobile ad hoc networks. This paper delivers a state-of-the-art overview of multicast routing protocols for ad hoc networks. This survey will prove to be a great source of information for researchers in ad hoc networks. The survey tries to review typical tree-based and mesh-based multicast routing protocols, generally the tree based protocols are efficient than mesh based ones from the perspective of energy

efficiency generated by the minimization of transmission redundancy, whereas mesh based protocols provide better reliability at the cost of redundancy.[14]

II. Experimental Setup

QualNet5.0 is a comprehensive suite of tools for modeling large wired and wireless networks. It uses simulation and emulation to predict the behavior and execution of networks to improve their design, operation and management.

QualNet5.0 enables users to:

➢ Design new protocol models.

➢ Optimize new and existing models.

➢ Design large wired and wireless networks using pre-configured or user-designed models.

➢ Analyze the performance of networks and perform what-if analysis to optimize them.

III. WORK DONE

The network size is 1500m × 1500m area for scenario simulation. There is no network partitioning throughout the entire simulation. The data transmission rate (unicast and multicast) and data transmission rate for broadcast is 2Mbits/s. At physical layer PHY 802.11b and at MAC layer MAC 802.11 is used. The simulation time for each experiment is 300 seconds. Multiple runs with different seed numbers are conducted for each scenario and collected data is averaged over those runs.

➢ The main traffic source in the simulation is Constant Bit Rate (CBR) traffic. Each multicast group has one sender for each protocol every time but the number of

receivers is different for different number of nodes. The number of receivers is 3, 6, 9 for 20 nodes, 40 nodes and 60 nodes respectively. The sender transmits multicast traffic at a rate from 10 to 60 packets /sec. The senders and receivers are chosen randomly among multicast members. A member joins the multicast session at the beginning of the simulation and remains as a member throughout the simulation. In the simulation, initial 10s is kept to perform this task. Once joining the multicast group, we let the source to transmit data for 300s simulation time. The packet size without header is 512 bytes. The length of the queue at every node is 50 Kbytes where

Area	1500X1500 m^2
Transmission range	500 m
Number of nodes	200
Physical / Mac layer	IEEE 802.11 at 2 Mbps
Mobility model	Group model, Random waypoint model
Maximum mobility speed	1-20 m/s
Simulation duration	300 s
Pause time	30 s
Packet size	512 bytes
Traffic type	CBR (Constant Bit Rates)
Number of packets	5/second
Number of multicast sources	1,2,5,10,15 nodes
Number of multicast receivers	20,40,60 nodes
No. of simulations	20

IV. Description of Protocols

Distance Vector Multicast Routing Protocol (DVMRP)

DVMRP is a distance vector routing protocol. It uses flooding and pruning to build the multicast tree. The routers in the leaf subnets have group membership information. When a router receives a flooded packet, it knows whether that packet will be useful for its subnet or not. In case there is no group member on the subnet, the leaf router sends a prune message to its neighboring routers. In addition, a leaf router can send a prune message through all interfaces except for the one on the reverse shortest path to the sender. When an intermediate router receives prune messages from all interfaces except for the reverse shortest path interface, it forwards the prune message upstream. This way, the unwanted branches of the spanning tree get pruned off. When a router sends a prune message, it maintains information about the (Source, Group) pair for which the prune message was sent. This state is used to prevent propagation of the data packets when they arrive at those routers.

DVMRP is a soft-state protocol in the sense that the state in the routers times out, and hence the process of flooding and pruning needs to be repeated periodically.

On-demand Multicast Routing Protocol (ODMRP)

The On-Demand Multicast Routing Protocol (ODMRP) falls into the category of on-demand protocols since group membership and multicast routes are established and updated by the source whenever it has data to send. Unlike conventional multicast protocols which build a multicast tree, ODMRP is mesh based. It uses a subset of nodes, or forwarding group, to forward packets via scoped flooding. When a multicast source has data to send but no route or group membership information is known, it piggybacks the data in a Join-Query packet. When a neighbor node receives a unique Join-Query, it records the upstream node ID in its message cache, which is used as the node's routing table, and re-broadcasts the packet. This process' side effect is to build the reverse path to the source. When a Join-Query packet reaches the multicast receiver, it generates a Join-Table packet that is broadcast to its neighbors. The Join-Table packet contains the multicast group address, sequence of pairs, and a count of the number of pairs. When a node receives a Join-Table it checks if the next node address of one of the entries matches its own address.

PIM-DM (PROTOCOL INDEPENDENT MULTICAST–DENSE MODE)

This is PIM operating in dense mode (PIMDM), but the differences from PIM sparse mode (PIM-SM) are profound enough to consider the two modes separately. PIM also supports sparse-dense mode, with mixed sparse and dense groups, but there is no special notation for that operational mode. In contrast to DVRMP and MOSPF, PIM-DM allows a router to use any unicast routing protocol and performs RPF checks using the unicast routing table. PIM-DM has an implicit join message, so routers use the flood and prune method to deliver traffic everywhere and then determine where the uninterested receivers are. PIM-DM uses source-based distribution trees in the form (S, G), as do all dense-mode protocols.

V. Results and Discussion

The performance of DVMRP, ODMRP and PIM-DM are investigated and analyzed based on the results obtained from the simulation. A number of experiments are performed to explore the performance of these protocols with respect to a number of nodes Grid, Uniform, Random.
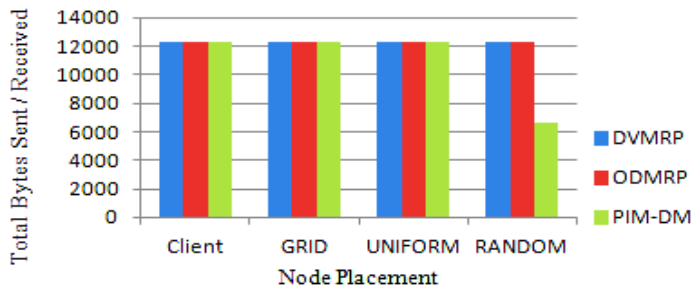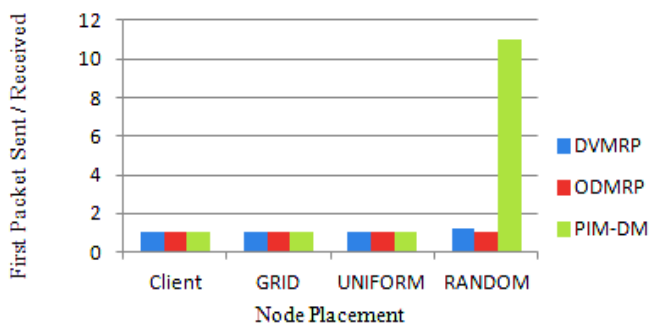

Fig6.1 No. of nodes Vs total bytes received

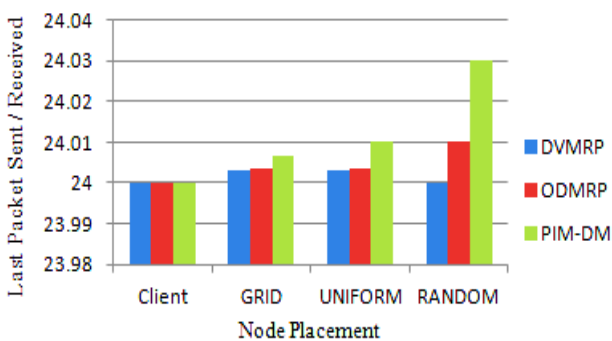Fig6.2 No. of nodes Vs first packet received

Fig6.3 No. of nodes Vs last packet received

From Fig.6.1 to 6.6, it is observed that all protocols performance is affected by the increasing number of nodes in the network. Increased network traffic results in packet loss due to buffer overflow and congestion. When nodes are placed as a grid, uniform and Random, total bytes received at server almost remain same as the no. of nodes increases as shown in Fig.6.1. shows the variation in received bytes with no. of nodes when node placement is uniform. Total bytes Received is increases for ODMRP for all these three protocols. It states that no. of bytes received increase from 20 to 60 nodes for all three protocols increase in Grid and Uniform node placement. Fig.6.2 shows the first packet sent from client and received at server. For 20, 40 & 60 nodes delay is highest for PIM-DM and lowest for ODMRP and same for DVMRP but sharply increases for 60 nodes. The delay is lowest for ODMRP and highest for PIM-DM in all modes. Finally increase in Random nodes placement only for PIM-DM. Fig.6.3 shows the last packet sent from client and received at server i.e. delay. The delay is highest for PIM-DM and lowest for ODMRP. For 20, 40 nodes DVMRP is lowest but after that 60 nodes delay packet of DVMRP is highest and PIM-DM is almost same. Fig.6.4 shows the Total packet sent from client and received at server for three protocols when nodes are placed as uniform. For 20, 40 and 60 nodes, PDR is almost increases for ODMRP for all three protocols. For overall in Total packet Received increases in Uniform node placement.
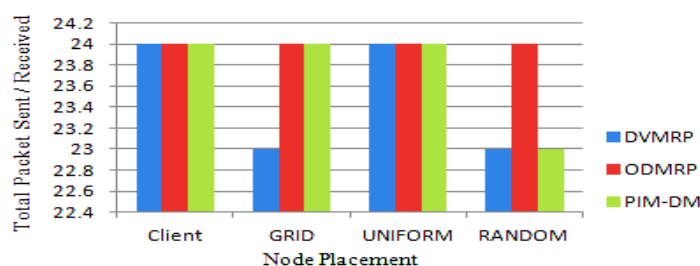

Fig6.4 No. of nodes Vs total packet received

VI. Conclusion

From the investigation, it can be concluded that proactive multicast routing protocols are not suitable for mobile ad hoc networks (MANETs), because of their huge routing overheads. Among the other two reactive routing protocols, mesh based (ODMRP) shows better performance than tree based routing protocol. ODMRP has low packet loss, high packet delivery ratio (PDR), as compared to other tree-based routing protocols .i.e DVMRP and PIM-DM. It was concluded that there is a trade-off between number of dropped packet and delay. As we studied from the analysis the delay should be reduced. If the number of dropped packets was decreased with the help of buffer, ODMRP uses a forwarding group, to forward packets to receiver via scoped flooding.

VII. References

[1] Anuradha Banerjee et. al. "A Survey of Multicast Routing Protocols for Mobile Ad Hoc Networks", in the International Journal of Engineering Science and Technology, Vol. 2(10), 2010, 5594-5604.

[2] Busola S. Olagbegi1 and Natarajan Meghanathan "A review of the energy efficient and secure multicast routing protocols for mobile ad hoc networks", in the International journal on applications of graph theory in wireless ad hoc networks and sensor networks (GRAPH-HOC) Vol.2, No.2, June 2010.

[3] David A. Maltz, Josh Broch, Jorjeta Jetcheva, and David B. Johnson, Member, IEEE, "The Effects of On-Demand Behavior in Routing Protocols for Multihop Wireless Ad Hoc Networks", IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, VOL. 17, NO. 8, AUGUST 1999.

[4] K. Paul, S. Bandyopadhyay, D. Saha and A. Mukherjee," Communication-Aware Mobile Hosts in Ad-hoc Wireless Network" ,in the Proc. of the IEEE International Conference on Personal Wireless Communication, Jaipur, India, Feb. 1999.

[5] Sung-Ju Lee, William Su, Julian Hsu, Mario Gerla, and Rajive Bagrodia, "A Performance Comparison Study of Ad Hoc Wireless Multicast Protocols", 0-7803-5880-5/00/$10.(0c0) 2000 IEEE.

[6] A Tutorial by Laxman H. Sahasrabuddhe and Biswanath Mukherjee "Multicast Routing Algorithms and Protocols". This work has been supported in parts by the National Science Foundation (NSF) under Grants Nos. NCR 9508238 and ANI-9XO52U5 IEEE Network * January/February 2000.

[7] A Ganguli, S Nandi, P K Meher "An improvement of ODMRP for reliable delivery of busty traffic", 0-7803-7651-X/03/$ 17.00 ©2000 IEEE.

[8] Sang Ho Bae, Sung-Ju le;, William Su, and Mario Gerla, "The Design, Implementation, and Performance Evaluation of the On-Dem and Multicast Routing Protocol in Multihop Wireless Networks", 0890-8044/00/$10.00 © 2000 IEEE.

[9] Subir Kumar Das, B. S. Manoj & C. Siva Ram Murthy "A Dynamic Core Based Multicast Routing Protocol for Ad hoc Wireless Networks". Mobihoc 2002: 24-35.

[10] Yoav Sasson ,David Cavin & Andr´e Schiper "A Location Service Mechanism for Position-Based Multicasting in Wireless Mobile Ad hoc Networks", in the IC/2003/29.

[11] Weisheng Si and Chengzhi Li "RMAC: A Reliable Multicast MAC Protocol for Wireless Ad Hoc Networks" in the International Conference on parallel processing 2004, Vol.1, Pages : 494-501.

[12] Pedro M. Ruiz, and Antonio F. Gomez-Skarmeta "Mobility-Aware Mesh Construction Algorithm for Low Data-Overhead Multicast Ad hoc Routing", in the Journal of communications and networks, VOL. 6, NO. 4, DECEMBER 2004.

[13] Jorjeta G. Jetcheva and David B. Johnson "A Performance Comparison of On-Demand Multicast Routing Protocols for Ad Hoc Networks" December 15, 2004, CMU-CS-04-176.

[14] A. Sabari & K. Duraiswamy "Ant Based Adaptive Multicast Routing Protocol (AAMRP) for Mobile Ad Hoc Networks", in proc. of the IEEE 2008.

[15] Aparna K "Performance Comparison of MANET (Mobile Ad hoc Network) Protocols (ODMRP with AMRIS and MAODV)" in the International Journal of Computer Applications (0975 – 8887) 2010 ,Volume 1 – No. 10.

[16] M. Nagaratna, Dr. V. Kamakshi Prasad, Dr. C. Raghavendra Rao "Performance Evaluation of Tree - Based Multicast Routing Protocols in MANETs" in the proc. Of the IJCST Vol. 2, Issue 3, September 2011.