An Overview of Performance of Multicast Routing Protocols for Wireless Networks: A Literature Survey

[1]Tumesh Kumar Sen, [2]Chandrakant Mahobia
[1]M.Tech. Scholar, [2]Assistant Professor
[1]Computer Science Department,
[1]School of Engineering & IT, MATS University, Aarang campus-Gullu, Raipur, Chhattisgarh, India

***Abstract* - For proper group communication requires a good network maintenance which has triggered Multicasting environment including real time applications such as multipoint data dissemination and multiparty conferencing tools. These applications are supported with multicast routing protocols. There are several multicast routing protocols have been proposed and implemented, and still this is an area of active research for the past couple of years. In this article, it is tried to summarize the performance of several multicasting protocols by surveying several existing multicast routing protocols. This paper also presents the classification of multicast routing protocols and some current research issues in these protocols design.**

***Index Terms* - Wireless Network, Multicast Routing, ODMRP, MAODV, PUMA, Research issues**

I. INTRODUCTION

A wireless network is a collection of wireless nodes that communicate with each other over wireless connections. There are several multicast routing protocols which have been offered in the past few years. Based on the routing structure they can be grouped into two categories: tree-based protocols and mesh-based protocols. The tree-based multicast routing protocol survives a single route between any sender-receiver pair and occupies the advantage of high multicast efficiency. These protocols are not built-up strong against frequent topology changes and consequently drop the data packet at highly mobile environment. The mesh-based multicast routing protocols provides the redundant routes to group members for maintaining connectivity. The problem of low packet delivery ratio due to frequent link failure is alleviated because of redundant routes. However mesh-based multicast routing protocols are better against node mobility but give low multicast efficiency. A hybrid multicast routing provides the advantage of mesh-based and tree-based protocols [1].

Multicast is simple one -to-many or many-to-many distribution. It is group communication where information is directed to a group of destination computers simultaneously. A multicasting scenario can be shown as in Figure 1. The figure 1 shows the transmission of information from multiple sources to multiple destinations. This is becoming a central demand of computer networks which sustain multimedia applications. A multicast network must be able to support large number of multicast sessions efficiently. In such networks, information exchanged in those sessions using as few network resources as much as possible relying on the session's service necessities.

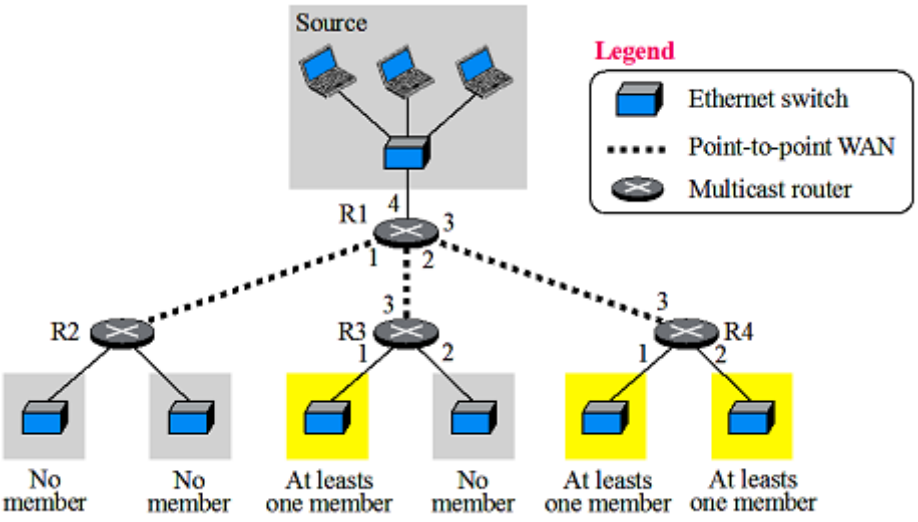

Figure 1: Multicasting Scenario [2]

The main objectives of multicasting routing are every member receives exactly one copy of the packet and non-members receive nothing, then there should not be any loops in the route and also have an optimal path from the source to each destination.

II. MULTICAST ROUTING PROTOCOLS

In this section some basic multicast routing protocols are described.

A. **ON DEMAND MULTICAST ROUTING PROTOCOL (ODMRP):** ODMRP stands for on-demand multicast routing protocol [3], [4], [5], [6], [7]. It is a mesh based and a source initiated protocol. ODMRP uses the forwarding group concept to establish a mesh network. A "soft state" approach is followed by it to maintain a mesh.

B. **PROTOCOL FOR UNIFIED MULTICASTING THROUGH ANNOUNCEMENT (PUMA):** PUMA stands for protocol for unified multicasting through announcement. It is distributed, receiver initiated and mesh-based protocol [8], [9]. Its transmissions are broadcast in nature and do not depend on any uni-cast protocol. In this protocol, a multicast group has a special node called core node. This core node is connected with every receiver along the shortest path and forms a mesh like structure. The sender can send a data packet to multicast group along any of the shortest path between core node and sender node.

C. **MULTICAST ADHOC ON DEMAND DISTANCE VECTOR PROTOCOL (MAODV):** MAODV stands for multicast ad-hoc on demand distance vector protocol. It is the multicast extension of AODV protocol [10], [11]. It discovers multicast routes on demand using a broadcast route-discovery mechanism and is a hard state reactive tree based routing. Since MAODV is an on-demand routing protocol, therefore, it allows to follow traditional scheme for maintaining routing table i.e. each destination has only one entry in the routing table.

D. **OVERLAY BORUVKA-BASED ADHOC MULTICAST PROTOCOL (OBAMP):** OBAMP stands for overlay boruvka-based adhoc multicast protocol [12]. It is a mesh-first overlay multicast protocol [12] with Boruvka algorithm. It uses the transport layer tunnels for sending information to other nodes. Boruvka algorithm is used to find the minimum spanning tree. This protocol is aimed to reduce network traffic load in order to maximize delivery ratio and minimize delay. At start up, it constructs an overlay network spanning of all members (i.e., a mesh), then it builds the distribution tree by selecting a subset of non-cyclic overlay links belonging to the mesh.

E. **APPLICATION LAYER MULTICAST ALGORITHM (ALMA):** ALMA stands for application layer multicast algorithm [13]. It is a receiver-driven, flexible and a highly adaptive overlay multicast protocol. An overlay multicast tree of logical links is constructed between the multicast group members in dynamic, decentralized and incremental way. ALMA is so called receiver-driven because the member nodes of multicast group find their neighbors according to their needs. ALMA is so called flexible because it can satisfy the needs of a wide range of applications and its performance goals. ALMA is so called highly adaptive because it reconfigures the multicast tree in response to mobility or congestion.

F. **APPLICATION LAYER MULTICAST ALGORITHM-HIERARCHICAL (ALMA-H):** ALMA-H stands for application layer multicast algorithm-hierarchical [13]. It is an enhanced version of ALMA in terms of tree efficiency. It is same as ALMA protocol like receiver-driven, flexible and a highly adaptive overlay multicast protocol. In ALMA-H protocol, a Unique shared tree is formed which is not dependent source node of the group but it depends only on member of the group. The metric selected in ALMA-H is number of hops for parent selection while the metric selected in ALMA for parent selection is round trip time.

III. RELATED WORK

A multicast routing protocol supports the distribution of information from a sender to all the receivers of a multicast group. It uses the available bandwidth efficiently in the presence of frequent topology changes. One-to-many multicast data dissemination is needed frequently in critical situations such as disaster recovery or battlefield scenarios [14]. There were many multicast routing protocols primarily designed but they still face lot of challenges like limited energy, limited bandwidth, short memory, limited processing ability, scalability and robustness [15], [16], [17], [18].

Sung-Ju Lee et al [19] evaluated the scalability and performance of ODMRP for adhoc wireless networks. **R.Vaishampayan [20]** pointed out the mesh based and tree based multicast routing for Mobile Ad-hoc Networks with varying the parameters of mobility, group members, number of senders, traffic nodes, the number of multicast groups and concluded that PUMA attains higher packet delivery ratios than ODMRP and MAODV.

Andrea Detti et al [21] proved that OBAMP has a low- latency and a high delivery ratio with increasing group size and compared it with two state-of-the-art protocols, namely ODMRP and ALMA.
Pandi Selvam et al [22] compared the performance of two on-demand multicast routing protocols, namely MAODV and ODMRP in MANET. **Sejal Butani et al [23]** chosen PUMA protocol for multicast ad hoc network, various multicasting protocols compared and concluded that PUMA provides less routing overhead, high throughput and better packet delivery ratio as compared to MAODV and ODMRP.

A.M. Zungeru et.al [24] compared the different MANET routing protocols and presented a comprehensive survey in WSN, **Abid ali minhas et.al [25]** compared the MAODV, TEEN, SPEED, MMSPEED for WSN.

Table.1. Characteristics comparison of multicast routing protocols

Characteristics	Multicast Routing Protocol					
	Reactive			Proactive		
	ODMRP	MAODV	PUMA	OBAMP	ALMA	ALMA-H
Multicast Topology	Mesh	Tree	Mesh	Tree	Tree	Tree
Initiation	Source	Source	Receiver	Receiver	Receiver	Receiver
Control Overhead	Low	Low	Low	High	High	High
Dependency	Autonomous	Unicast based	Autonomous	Dependent	Dependent	Dependent
Maintenance	Soft	Hard	Soft	Soft	Soft	Soft
Periodic Control message	Yes	Yes	Yes	Yes	Yes	Yes
Routing Approach	Flat	Flat	Flat	Flat	Flat	Flat

Some basic multicast routing protocols have been analyzed theoretically and comparative characteristic table is presented among them. The theoretical analysis shows that ODMRP, MAODV and PUMA have low control overhead protocols because reactive multicast routing protocols maintained limited on-demand routing table, while OBAMP, ALMA, ALMA-H showed high control overhead because proactive multicast routing protocols maintained many routing tables.
After comparing all above protocols, one can conclude that ODMRP and PUMA are better multicasting routing protocols and showed better characteristics than the other multicast protocols.

IV. RESEARCH ISSUES

The multicast routing protocol design must include three issues into supervision: robustness, multicast efficiency, and control overhead. Whenever the degree of robustness is low, the packet delivery ratio will drop and high control overhead will be incurred. Therefore, the mesh structure is more appropriate to be the multicast routing structure. The number of forwarding nodes in mesh is limited such that some degree of multicast efficiency is ensured. A mesh network which is built and maintained by only one core node is robust to low mobility and can avoid duplicate transmissions. However, this kind of mesh may not be robust enough to high mobility. From author opinion, an excellent mesh-based protocol could be designed with the connectivity adapted to the degree of mobility.
A mesh network is constructed and refreshed by one core node, so the position of the core node affects the efficiency of the mesh. Multicast efficiency is reduced whenever the core node is located far away from other group members and longer paths increase the probability of link failures. How to design an efficient core migration scheme with low overhead is a crucial issue. From author opinion, the soft-state maintenance could be used only for refreshing the mesh; while the hard-state could be used for repairing broken links.
Generally all multicast routing protocols provide shortest paths between senders and receivers. This may lead to reduce multicast efficiency because shortest paths have low delay on data delivery and fewer probabilities of link failures. Hence, the protocol should strike a balance between multicast efficiency and path lengths. Several protocols combine separated meshes using core node with the highest IP address to be the new core of the merged mesh. But this merging procedure is inefficient and time-consuming. From author opinion, it is better for one of the group members that which can detect more than one mesh tree accessible to be the new core node because these members are located in the middle of these separated meshes.

V. CONCLUSION

In this paper, some basic multicast routing protocols for wireless network are discussed. These protocols endeavor some tricky harder problems which can be categorized under basic issues or characteristics. All protocols have their own advantages and disadvantages. Author analyzed the performance of multicast routing protocol theoretically and presented the comparative table based on their characteristics. At last some research issues are discussed and stated difficulty to design a multicast routing protocol.

REFERENCES

[1]. Junhai, Luo and Danxia, Ye and Liu, Xue and Mingyu, Fan "A comprehensive survey of multicast routing protocols for mobile ad hoc networks.", IEEE Communications Surveys & Tutorials, Vol.11, No-1, pp. 25-34, 2008.
[2]. Prabhu Kichadi and Yashavanth T R, "A Survey on Multicast Routing Protocols for Mobile Ad-Hoc Networks", International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181,Vol. 4 Issue 04, April-2015.
[3]. Jing Dong, Reza Curtmola and Cristina Nita-Rotaru, "Secure High-Throughput Multicast Routing in Wireless Mesh Networks", IEEE Transactions on Mobile Computing, Vol. 10, No. 5, pp. 653-668, 2011.
[4]. Sung-Ju Lee, William Su and Mario Gerla, "On-demand multicast routing protocol in multihop wireless mobile networks", Mobile Networks and Applications, Vol. 7, No. 6, pp. 441-452, 2002.
[5]. Elizabeth M. Royer and Charles 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, pp. 207-218, 2000.
[6]. S.-J. Lee, W. Su and M. Gerla, "On-Demand Multicast Routing Protocol (ODMRP) for Ad Hoc Networks", Network Research Lab, 1999.

[7]. S.-J. Lee, M. Gerla and Chai-Keong Toh, "A Simulation Study of Table-Driven and On-Demand Routing Protocols for Mobile Ad-Hoc Networks", IEEE Network, Vol. 13, No. 4, pp. 48-54, 1999.
[8]. R. Vaishampayan and J. J. Garcia-Luna-Aceves, "Efficient and robust multicast routing in mobile ad hoc networks", IEEE International Conference on Mobile Ad-hoc and Sensor Systems, pp. 304-313, 2004.
[9]. Sejal Butani, Shivani Desai and Sharada Valiveti, "Providing Efficient Security in Multicast Routing for Adhoc Networks", International Journal of Computer Science and Telecommunications, Vol. 3, No. 6, pp. 29-34, 2012.
[10]. Abid Ali Minhas, Fazl-e-Hadi, Danish Sattar, Kashif Mustaq and S. Ali Rizvi, "Energy Efficient Multicast Routing Protocols for Wireless Sensor Networks", World Congress on Sustainable Technologies, pp. 178-181, 2011.
[11]. Osamah S. Badarneh and Michel Kadoch, "Multicast Routing Protocols in Mobile Ad Hoc Networks: A Comparative Survey and Taxonomy", EURASIP Journal on Wireless Communications and Networking, pp. 1-42, 2009.
[12]. Andrea Detti, Nicola Blefari-Mezzi and C. Loreti, "Overlay, Boruvka-based, ad-hoc multicast protocol: description and performance analysis", IEEE International Conference on Communications, pp. 5545-5552, 2007.
[13]. Min Ge, Srikanth V. Krishnamurthy and Michalis Faloutsos, "Application versus network layer multicasting in ad hoc networks: the ALMA routing protocol" , Ad Hoc Networks, Vol. 4, No. 2, pp. 283-300, 2006.
[14]. K. Obraczka and G. Tsudik, "Multicast Routing Issues in Ad Hoc Networks", IEEE International Conference on Universal Personal Communications, Vol. 1, pp. 751-756, 1998.
[15]. I. F. Akyildiz, Weilian Su, Y. Sankarasubramaniam and E. Cayirci, "A Survey on Sensor Networks", IEEE Communications Magazine, Vol. 40, No. 8, pp. 102-114, 2002.
[16]. Juan A. Sanchez, Pedro M. Ruiz, Jennifer Liu and Ivan Stojmenovic, "Bandwidth-Efficient Geographic Multicast Routing Protocol for Wireless Sensor Networks", IEEE Sensors Journal, Vol. 7, No. 5, pp. 1092-1648, 2007.
[17]. L. Su, Bolin Ding, Yong Yang, T. F. Abdelzaher, G. Cao and J. C. Hou, "Ocast: Optimal multicast routing protocol for wireless sensor networks", Proceedings of 17th IEEE International Conference on Network Protocols, pp. 151-160, 2009.
[18]. Adamu Murtala Zungeru, Li-Minn Ang and Kah Phooi Seng, "Classical and Swarm Intelligence Based Routing Protocols for Wireless Sensor Networks: A survey and Comparison", Journal of Network and Computer Applications, Vol. 35, No. 5, pp. 1508-1536, 2012.
[19].Sung-Ju Lee, William Su and Mario Gerla, "On-demand multicast routing protocol in multihop wireless mobile networks", Mobile Networks and Applications, Vol. 7, No. 6, pp. 441-452, 2002.
[20]. R. Vaishampayan and J. J. Garcia-Luna-Aceves, "Efficient and robust multicast routing in mobile ad hoc networks", IEEE International Conference on Mobile Ad-hoc and Sensor Systems, pp. 304-313, 2004.
[21]. Andrea Detti, Nicola Blefari-Mezzi and C. Loreti, "Overlay, Boruvka-based, ad-hoc multicast protocol: description and performance analysis", IEEE International Conference on Communications, pp. 5545-5552, 2007.
[22]. T. He, J.A. Stankovic, Chenyang Lu and T. Abdelzaher,"SPEED: A stateless protocol for real-time communication in sensor networks", 23rd International Conference on Distributed Computing Systems, pp. 46-55, 2003.
[23]. Sejal Butani, Shivani Desai and Sharada Valiveti, "Providing Efficient Security in Multicast Routing for Adhoc Networks", International Journal of Computer Science and Telecommunications, Vol. 3, No. 6, pp. 29-34, 2012.
[24]. Adamu Murtala Zungeru, Li-Minn Ang and Kah Phooi Seng, "Classical and Swarm Intelligence Based Routing Protocols for Wireless Sensor Networks: A survey and Comparison", Journal of Network and Computer Applications, Vol. 35, No. 5, pp. 1508-1536, 2012.
[25]. Abid Ali Minhas, Fazl-e-Hadi, Danish Sattar, Kashif Mustaq and S. Ali Rizvi, "Energy Efficient Multicast Routing Protocols for Wireless Sensor Networks", World Congress on Sustainable Technologies, pp. 178-181, 2011.