Multicast Routing Protocols with Low Overhead For MANET

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***Abstract* - This paper presents a thorough survey of current work addressing multicast routing protocols with low control overhead in Mobile Ad hoc Networks (MANETs). There are so many different issues and solutions which witness the need of group management in ad hoc wireless networks. The goal of a multicast routing protocol for MANETs is to support the propagation of data from a sender to all the receivers of a multicast group while trying to use the available bandwidth efficiently in the presence of frequent topology changes. Multicasting can improve the efficiency of the wireless link by sending multiple copies of messages by exploiting the inherent broadcast property of wireless transmission. However, offering multicast routing with minimum control overhead is very difficult and challenging task. Now a day, various multicast routing protocols have been proposed for MANETs. All these protocols have their distinguishing features and use different mechanisms to support the different Quality of Services parameters.**

***Keywords* - Control Overhead, Mobile Ad hoc Network, routing zone, Shared tree**

I. INTRODUCTION

An ad hoc network consists of a collection of autonomous mobile nodes formed by means of multi-hop wireless communication without the use of any existing network infrastructure. Ad hoc networks have become increasingly relevant in recent years due to their potential applications in battlefield, emergency disaster relief and etc. In an ad hoc network, each mobile node can serve as a router. A mobile ad-hoc network (MANET) is characterized by mobile nodes without any infrastructure. Mobile nodes self-organize to form a network over radio links [20].Group communication are important in Mobile Ad Hoc Networks (MANET). Many ad hoc Network applications which require close association of the member nodes depends on group communication. Disaster relief, conferences, action directions given to the soldiers in a battlefield and communications required during a rescue operation are some examples of these applications. In addition, many routing protocols for wireless MANETs need a broadcast/multicast as a communication primitive to update their states and maintain the routes between nodes [1],[15].

Multicast protocols can be categorized in tree based and mesh based protocols. Multicast tree structures are frail therefore need to be readjusted and repaired continuously as the connectivity changes. Even in wired networks maintaining group membership information and building an optimal multicast distribution structure (typically in the form of a routing tree) is challenging. A detailed survey of the work done in that area and a discussion of various design tradeoffs can be found in [2]. One particularly challenging environment is a mobile ad-hoc network (MANET). Nodes are free to move arbitrarily. Bandwidth scarcity, limited power resource, and above all dynamicity of topology in a mobile ad hoc network make the multicast protocol design predominantly challenging than that for wired network [15].

The primary goal of an ad hoc routing protocol is to establish a correct and efficient route between any pair of nodes with minimum overhead. Routing overhead is a very important metric. If the control overhead of a proposed method is very high, then that method cannot work well in MANET. It would be a difficult and challenging task to offer optimal, reliable, energy efficient with low control overhead multicast routing in MANETs. In recent years, various multicast routing protocols have been proposed to reduce various overheads during routing. These protocols have unique attributes and utilize different recovery mechanisms on overhead reduction. This paper will provide a comprehensive understanding of these multicast routing protocols and better organize existing ideas and work to make it easy to design multicast routing in MANETs. The goal of this paper is to help researchers to gain a better understanding of routing protocols with low control overhead available and assist them in the selection of the right protocol for their work. The rest of the paper is organized as follows: Section 2 presents related work on comparisons and surveys of multicast routing protocols for MANETs. Section 3 describes the various multicast routing protocols with low control overhead and Section 4 concludes the paper.

II. RELATED WORK

A number of multicast protocols have been proposed to provide multicasting in MANET like challenging environments [3],[4]. A multicast packet is delivered to all the receivers belong to a group along a network structure such as tree or mesh, which is constructed once a multicast group is formed. Based on this network structure, multicast protocols can be broadly categorized into two types, namely tree-based multicast and mesh-based multicast. A tree based multicast routing protocol is either a source-tree or a shared-tree protocol. In a source tree based multicast routing protocol data packets are delivered through multiple source-based routing trees routed at the sources of the multicast session and in shared tree protocol data packets are delivered along a shared multicast tree for the whole multicast group. Shared tree protocols construct a single tree for a multicast group which is shared by all senders. If the nodes in the network are highly dynamic, a large number of source trees might need reconstruction, causing excessive overhead in case of source-tree multicast [5]. On the other hand, shared tree multicast is more scalable because of lower control overhead requirement for maintaining only a single shared tree for all multicast sources [6]. The shared tree approach has some other drawbacks. The paths are non-optimal and traffic is concentrated on the shared tree, rather than being evenly distributed across the network. The shared tree based protocols need a group leader (or a core or a rendezvous point) to maintain group information and to create multicast trees. To deal with the problem of dynamic nature of MANET, mesh based protocols provide a number of redundant paths between a pair of sender and receiver. This in turn results in a great number of control overhead [15].

Tree based protocols are generally more efficient in terms of data transmission, but they are not robust against topology changes as there is no alternative path between a source and a destination, while mesh based protocols are more robust against topology changes due to availability of many redundant paths between mobile nodes, resulting in high packet delivery ratio. On the other hand, multicast mesh does not perform well in terms of low overhead because mesh-based protocols depend on broadcast flooding within the mesh and therefore, involving many more forwarding nodes than multicast trees. In summary, the broadcast forwarding in mesh based protocols produces redundant links, which improves the packet delivery ratio but increase more number of control packets in flooding than the tree-based multicast [15].

III. SURVEY OF MULTICAST ROUTING PROTOCOLS WITH LOW OVERHEAD

We can say that a MANET consists of dynamic collections of low power nodes with quickly changing multi-hop topologies that usually composed of relatively low bandwidth wireless link. All these constraints make multicasting in MANETs challenging. The design of the new multicast routing protocols for MANETs are driven by specific goals and requirements based on respective assumptions about the network properties or application areas. All new protocols have their own advantages and disadvantages. Some of them construct multicast trees to reduce end-to-end latency while others build mesh to ensure robustness. Research in the area of multicast over MANETs is far from exhaustive. Much of the effort so far has been on devising routing protocols to support effective and efficient communication between nodes that are part of a multicast group. It is really difficult to design a new multicast routing protocol considering all the above mentioned issues.

The goal of the research is to design a new tree based routing algorithm for multicasting which will reduce the total number of the control packets, transmitted by the source to other node of the group for communication so that we can reduce the control overhead of the whole network. There are various protocols designed to reduce the control packets. There are various methods proposed by various researchers in this direction to reduce control overhead. During route discovery process, tree-reconstruction phase or during group management process, modifying existing methods, we can do reduction in total number of required control packets. So that they can give new application independent protocol with low control overhead.

3.1 EGMP: Efficient Geographic Multicast Protocol

EGMP [7] uses a virtual-zone-based structure to implement scalable and efficient group membership management. A network wide zone-based bidirectional tree is constructed to achieve more efficient membership management and multicast delivery. The position information is used to guide the zone structure building, multicast tree construction, and multicast packet forwarding, which efficiently reduces the overhead for route searching and tree structure maintenance. Several strategies have been proposed to further improve the efficiency of the protocol, for example, introducing the concept of zone depth for building an optimal tree structure and integrating the location search of group members with the hierarchical group membership management. Finally, we design a scheme to handle empty zone problem faced by most routing protocols using a zone structure. The scalability and the efficiency of EGMP are evaluated through simulations and quantitative analysis. Our simulation results demonstrate that EGMP has high packet delivery ratio, and low control overhead and multicast group joining delay under all test scenarios, and is scalable to both group size and network size. Compared to Scalable Position-Based Multicast (SPBM) [17], EGMP has significantly lower control overhead, data transmission overhead, and multicast group joining delay.

3.2 LIFT: An Efficient Cross-layer Service Discovery Protocol

This paper [9] introduces a combination of a cluster based service discovery approach with a cross-layer service discovery scheme in order to discover services in Mobile Ad Hoc Networks. In this new proposal, High Capability Devices (HCD) are differentiated from Limited Capability Devices (LCD). HCD are set up as the cluster leaders in each cluster so as to perform most of the service discovery activities. Consequently, messages, memory, energy, computing processes, and bandwidth were reduced due to the optimum usage of network resources. We implemented LIFT on the network simulator NS-2 under various mobility conditions and cluster topologies. In order to know if our model achieves its goal to minimize resources, we have compared LIFT with another well-known solution (AODVSD) in terms of control message overhead and energy consumption. After carrying out many trials and simulations, LIFT improved previous results in the area

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3.3 SERC/LC3R: Smooth and Efficient Re-Clustering/ Localized Cluster-based Rerouting and Resource Reservation Protocol

This paper [11] presents a new paradigm to enhance the cluster stability and support the route reliability in the cluster-based ad hoc routing protocols. This paradigm is based on providing a secondary cluster head (SCH) for each cluster head which we call here primary cluster head (PCH). This SCH, which is a regular member node, is identified and assigned by its PCH to be the future leader of the cluster. The SCH will be triggered to be the PCH when the former PCH can no longer be a cluster head. To enhance the cluster stability, this paradigm introduces a new protocol to reform the cluster, namely the Smooth and Efficient Re-Clustering (SERC) protocol. In SERC, since the future cluster head is known by the cluster members, the cluster leadership will be transferred smoothly and the cluster will be reformed immediately with no need to invoke the clustering algorithm. To support the route reliability, this paradigm provides a new multipath routing protocol, which is named a Localized Cluster-based Rerouting and Resource Reservation Protocol (LC3R). In LC3R, the main route can be established through the PCH chains, while the backup route can be established through the SCH chains. In this study, we show how the SERC/LC3R works and how this paradigm can achieve a high packet delivery rate with saving clustering and routing overhead.

3.4 NAMP: Neighbor Aware Multicast Routing Protocol

Author proposed an efficient routing protocol for ad hoc networks which we named as NAMP [13]. NAMP aims at achieving higher performance by reducing control overhead and improvement of the end to- end delivery of data packets. It is a tree based, hybrid multicast routing protocol. For route creation, NAMP uses the neighbouring information and dominant pruning approach. For ensuring robustness in this tree based protocol, NAMP maintains a secondary forwarder list at the time of creating the tree structure. The neighbourhood awareness improves the routing mechanism as at each node level, the topological information of at least two hops away is available. By using the dominant pruning method for flooding of packets and route creation, it obviously utilizes the bandwidth available for the network.

3.5 STAMP: Shared-Tree Ad Hoc Multicast Protocol

The work of this paper [14] focuses on solving the two related challenges: to achieve efficient and adaptive multicast communications firstly inside each cluster and secondly among the clusters. This paper presents a solution regarding the first challenge. Compared to other shared tree multicast protocols, STAMP achieves good performance even under mobility since it takes advantage from the broadcast capacity of the medium to deliver data on the tree (data forwarding based on mesh principles). Discrete event simulations were run to evaluate and to compare new method to other existing solutions. STAMP allows multicast communications by the creation of a tree structure centered on a core node. The tree construction initiative is given to the receiver nodes which send join messages to their upstream neighbours on the path to the core. This path is known from a unicast routing protocol. As a MANET needs to provide not only multicast communications capability, but also unicast communications, authors have chosen to base our protocol on a unicast routing protocol without dictating any conditions on the choice except that it must provide path information within a finite delay. To reduce redundancy in controlling data exchange, STAMP tries to re-use as much as possible of the control information provided by the unicast protocol. This means, for instance, that if the unicast routing protocol detects link breakages from beaconing, STAMP does not need to implement its own mechanism. Protocol performances were observed in several network configurations with different parameters values in order to measure the impact of these parameters on the protocol. Simulation results show that two goals, to reach a delivery ratio close to the mesh ratio in almost all scenarios and to reduce the data and control overhead, were achieved.

3.6 CBLARHM: Cluster Based Location-Aware Routing Protocolfor Large Scale Heterogeneous MANET

In this paper [16], Authors have proposed a novel Cluster Based Location-Aware Routing Protocol for Large Scale Heterogeneous MANET (CBLARHM). There are two important mechanisms used in the CBLARHM to improve the MANET performance. Node clustering is an efficient technique to mitigate the topology changes in MANET. It stabilizes the end-to-end communication paths and improves the networks scalability so that the routing overhead does not become tremendous in large scale MANET. Another key challenge is controlling the total number of nodes involved in a routing establishment process so as to reduce the total routing overhead of the MANET. The mechanism used is to use the geographical location information provided by global positioning systems (GPS) to assist in routing. Instead of searching the route in the entire network blindly, position-based routing protocol uses the location information of mobile nodes to confine the route searching space into a smaller estimated range. Simulation results have shown that CBLARHM outperforms other protocols significantly in route setup time, routing overhead and collision, and simultaneously maintains a low average end-to-end delay, a high success delivery ratio, as well as low route discovery frequency.

3.7 LPBR: A location prediction based routing protocol

This paper [18] discusses a new location prediction based routing (LPBR) protocol for mobile ad hoc networks (MANETs) and its extensions for multicast and multi-path routing. The objective of the LPBR protocol is to simultaneously minimize the number of flooding-based route discoveries as well as the hop count of the paths for a source–destination (s–d) session. During a regular flooding-based route discovery, LPBR collects the location and mobility information of nodes in the network and stores the collected information at the destination node of the route search process. When the minimum-hop route discovered through flooding fails, the destination node locally predicts a global topology based on the location and mobility information collected during the latest flooding-based route discovery and runs a minimum-hop path algorithm. If the predicted minimum-hop route exists in reality, no expensive flooding-based route discovery is needed and the source continues to send data packets on the discovered route. Similarly, authors propose multicast extensions of LPBR (referred to as NR-MLPBR and R-MLPBR) to simultaneously reduce the number of tree discoveries and the hop count per path from the source to each multicast group receiver. Nodes running NR-MLPBR are not aware of the receivers of the multicast group. R-MLPBR assumes that each receiver node also knows the identity of the other receiver nodes of the multicast group. Finally, we also propose a node-disjoint multi-path extension of LPBR (referred to as LPBR-M) to simultaneously minimize the number of multi-path route discoveries as well as the hop count of the paths.

IV. CONCLUSIONS

A mobile ad hoc network (MANET) consists of groups of autonomous mobile nodes, each of which communicates directly with the nodes within its wireless range or indirectly with other nodes in a network. In order to facilitate reliable communication within a MANET, an efficient routing protocol is required to discover routes between mobile nodes. The area of MANET is rapidly growing because of the many advantages and various application areas. Control overhead, energy efficiency, security, reliability are some challenges faced in MANETs, especially in designing a routing protocol. In this paper, we consider a number of energy efficient multicast routing protocols. In many cases, it is very difficult to compare these protocols with each other directly since each protocol has its own goal with different assumptions and employs *mechanisms to achieve this goal. According to the* survey, these protocols have their strengths and drawbacks. Any multicast protocol can hardly satisfy all requirements. In other words, one routing protocol cannot be a solution for all QoS related issues that are faced in MANETs, but rather each protocol is designed to provide the maximum possible requirements, according to certain required scenarios. In future years, as mobile computing keeps growing, MANETs will continue to flourish, and even if a multicast protocol meeting all requirements it is designed for, it will be very complicated and will need a tremendous amount of routing information to be maintained. Satisfying most of the requirements would provide support for low control overhead, secure and reliable communication, minimize storage and resource consumption, ensure optimal paths and minimize network load.

V. REFERENCES

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