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Efficient Resource Allocation in Multicasting over Mobile Adhoc Networks

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Abstract

A Mobile Ad-hoc Network (MANET) represents an ad-hoc network which are able to change locations; which can also perform self-configuration and self-organization in a dynamic environment. Group communication system plays a major part in MANET environment which are implemented by multicasting method which provides delivery of packets to a group of destination. But there are many difficulties in implementing scalable, optimized and efficient multicasting network in mobile ad-hoc network because managing a dynamic environment with group membership is a challenging process. Efficient Geographic Multicast Protocol (EGMP) is proposed which uses a virtual zone base structure. The geographic region is divided into many virtual zones. The Distance between the source and other nodes in the group are found and the one closest to source is chosen as cluster head or zone leader. Zone leader communicates with its group members. Only zone leader transmits data and hence the node does not receive the same packets again and again. EGMP greatly simplifies zone management and packet forwarding. EGMP uses geographic forwarding to provide reliable packet transmission. It ensures the successful transmission of the data packets, has low overhead and reduced redundant packet transmissions. Compared with Scalable Position Based Multicast (SPBM), simulation results of EGMP shows high packet delivery ratio thus packet missing while transmission are reduced hence re-transmission of packets are reduced and bandwidth is utilized efficiently.

Keywords: Mobile Ad-hoc Network, Multicasting, Virtual Zone Based Structure

1. Introduction

Wireless technologies are being widely used these days because of their flexibility and low cost. Mobile Ad-hoc networks have a frequently changing topology as the nodes are free to move hence routing becomes a challenge. As the transmission range of the nodes is also limited, nodes cannot directly communicate with every other node. So there is a necessity for every node to decide on its routing path to reach the destination.

Mobile Ad-hoc Networks are being widely used in many scenarios like rescue missions, traffic managements, educational operations. There are two majors concerns in MANETs-firstly network partitioning can take place due to frequent node movements. Next packet losses may occur because of unpredictable nature of wireless links. MANETs require effective routing schemes to avoid hidden and exposed terminal problem, power restrictions and efficient bandwidth utilization. There are situations where many nodes in a group may have a common interest for some particular information. Multicasting performs well in such situations.

Multicast routing schemes must cope up with frequent node movements. For MANETs prevailing geographic routing protocol[1-4] assumes that the nodes are mindful of its position and it identifies its destination through location service[2,5,6]. Instead of sending message to the destination by using the network address source forwards the packet to the geographical location of the destination. By default greedy forwarding takes place which bring a message close to destination based on local information only. Every node forwards its packet to its neighbor which

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is utmost appropriate from the local point of view thus making a local optimal choice. When no such neighbor exists it may lead to dead end. In such situations perimeter forwarding is done which applies right hand rule to traverse the edges of void and find a path. Perimeter forwarding is done till greedy forwarding is restarted.

There are many challenges in implementing multicasting in MANETS. Consider an example, in which MULTICAST routing contains a packet header with destination position, when the size of group increases, the total number of destination increases which mentions all the destinations in the header will considerably increase the packet overhead. This limits the group size. Also, maintaining information about the group members becomes difficult. Each node forwards its packet to all of its neighboring nodes which in turn send the packet to their neighboring nodes irrespective of whether a node has already received the packet or not thus increasing redundancy. Even the nodes which are not involved in transmission process will be active hence resources will be wasted. Packet loss is considerably high as all the nodes send the same packet at the same time. Bandwidth is wasted as same packet is sent again and again.

We must use the resources efficiently; by using the available limited resource efficiently we can enjoy benefits in many ways. It depends on the number of operations performed in memory per second and the memory capability which bounds the quantity of data that can be stored. Both the issues greatly influence the overall through put. By utilizing the resources optimally redundancy is eliminated. The network wide redundancy elimination enhances the effective bandwidth utilization for large groups. Further Redundancy Elimination reduces data traffic and increase application performance by improving throughput and decreases delay.

2. Effective Routing

The performance of the MANET is evaluated by QOS; hence QOS limits the bound over bandwidth, latency and loss of packets during the transaction. The avoidance of the above parameters reduces the efficiency and performance of the applications. The reliable multicast routing comprises of processes like detection of error, indicating the error messages to source as well as destination and retransmitting the missed packets during packet loss. We propose EGMP protocol here to overcome the disadvantages of traditional tree and mesh based protocol[2,4,7-12].

3. Traditional Protocols

Traditional Mesh based trustworthy multicast routing mechanisms which is proposed in this paper includes some of these ideologies to attain reliable communication:

- To form the forwarding groups in a meshed structure for the purpose to forward the multicasting packets.
- Broadcasting must be controlled to decrease the overhead and enrich reliability
- A mesh is to be constructed among team leaders based on 2-tier hierarchical structure.
- Construct a spine.
- Several paths should be create between source and the destination
- Tree structure should be created based on multiple source based tree formation.

Packets containing data are being transmitted by forwarding group members, only if the nodes are active and the packets are not duplicated. To update the mesh routers a periodic control message are sent to it regularly. Each node maintains important database for routing table, for also the forwarding group table and the message cache. The Soft state mechanism is used by members of those who join or leave the node and database of each node is updated to maintain the latest information. Being vigorous in managing link connection and failures of nodes, this procedure has improved ratio of packet delivery and reduced control overheads. One more gain is the capability to perform function as unicast, as well as multicast.

The disadvantages of mesh based protocols are given below:

- When parent node fails its children nodes also fails.
- It is hard to update the optimal path in a periodic manner.
- Overhead is increased while maintaining the routers.
- Broadcasting nature increases the exponential growth of controlled packets with increase in nodes.
- Scalability is decreased.

In multicast trees of tree based mechanism, root node is considered to be the source and at the branches of every tree terminates when each of its destination is reached. The total number of tree structure is equivalent to the total number of source nodes, in which more than one tree share some branches which forms a tree mesh. Intrinsically, data are transmitted independently from all trees and every source originates its data. There exist only one route between a pair of source and destination in this approach, the collection of routes between source and destination procedures multicast tree. The trees are unidirectional the packets are sent to the root of the tree first.

Highly Efficient data forwarding and reduced overhead is delivered by Tree-based routing but it is not vigorous in high dynamic environments. Limited number of replicas of each packet is forwarded along with branches of the tree in this mechanism. Therefore the bandwidth is provided efficiency. Failure of linkselicits reconfiguration of the entire tree as the mobility of the nodes increases. When there are many sources, network maintains a shared tree, losing the optimal path or handling multiple trees which results in memory and out flows. There is also a possibility of loop formation.

4. EGMP

4.1 Protocol Overview

In EGMP[13] the geographic region is separated into non-overlying virtual zones. In every zone a leader is elected based on the energy level, mobility and inter-communication with the source. The leader looks after the local group management and acts as the representative for the zone in the upper layer. To attain an effective management of membership and multiple deliveries we construct a zone-based tree. This hierarchical two-tier structure improves scalability. For geographic protocols to work, the nodes must depend on localization techniques. In EGMP the location service is combined with zone structure. This position information is used for effective multicast packet forwarding. Thus searching the path and maintaining structure of the tree are made relatively simple. As the zone structure is virtualized, zone construction is not dependable on the network's terrain shape. The multicast tree is bi-directional in nature and hence the source can forward the multicast packets along the tree instead of sending them to the root. Inside the zone the forwarding decision is based on local distance information. EGMP can adapt very fast to changing network conditions as it needs to maintain only the membership change of the zones and not the movement of individual members.

In EGMP, a node announces its presence and position to its neighbors through periodic beacon messages. Thus, a node knows its self-location and the neighborhood-locations. Each node in the zone generates a neighbor table without additional signaling. Neighbor table contains the node ID, position and flag. The nodes periodically update their location information. If updates do not take place within a given timeout value then the node's entry is discarded. Nodes are added to the tree in the granularity of the zone rather than attaching them directly to the tree. This helps in better tree management. Anode while moving to a new or another zone it sends a request to the zone leader and broadcasts a BEACON message to the nodes in of the new zone. Its previous zone updates its position by receiving the BEACON message from it. Packet loss is minimal as the previous leader will keep sending the multicast packets to this node until it sends a LEAVE message. Each source of the group can propel messages along the tree structure. Sending data from the source to the root would incur some delay and this is avoided.

The destination is a virtual reference point. Using geographic forwarding, the list of best possible hops is chosen for each destination. A node keeps a packet only if it is one of the neighbor nodes or the destination.

5. Literature Review

Multicast protocols are categorized into three based on topology as Mesh, tree and zone. In mesh based protocol multiple paths exist between the source and destination. In such a protocol, management of link includes regular and periodic refreshing of path during dynamic node movement[14]. Further there is an overhead of maintaining redundant mesh paths. The tree based protocols are commonly more proficient for data communication but it is not effective in high dynamic environment. Multicast protocols based on conventional topology are difficult to construct and maintain. In a dynamic environment the group membership keeps changing and management becomes difficult when the size of group and network grow high. This inherent property makes it difficult to improve reliability[15].

In Scalable Position Based Multicast (SPBM)[16], every node in a particular zone lies within the range of communication between each other. Periodic flooding is generally done; such periodic flooding in regular interval is repeated for each neighboring nodes (between two nodes).When the size of the network grows, Substantial control overhead is produced as a consequence of membership flooding.

Geographic routing protocols[1-4] were developed to make transmissions and more efficient. These protocols assume that movable nodes are mindful of their self-locations through some system for positioning[17]. In these protocols, greedy forwarding approach is used to find the neighbor closest to destination. When no such neighbors can be identified, a dead end is reached. In order to recover from this, perimeter forwarding approach is used. Message Forwarding resolutions are made only on local information. This procedure does not work well for multicast routing because these protocols need to place the information of all every destinations in the packet header and which increases the header overhead. Thus, only small groups can use these protocols. In the previous model, multicasting is done but there is no confirmation that all packets are delivered to each and every node in the network. There is a probability that the packets are dropped somewhere in the network. That is why we go for our model "Effective Multicasting in MANET".

6. Methodology and Approach

In earlier systems, each and every wireless node inter communicates with each of its neighboring nodes. So flooding takes place and there is a probability of packet loss. There is also no guarantee that every node receives the multicast packets from the source. Also due to constant movement of nodes it is difficult to maintain a constant structure.

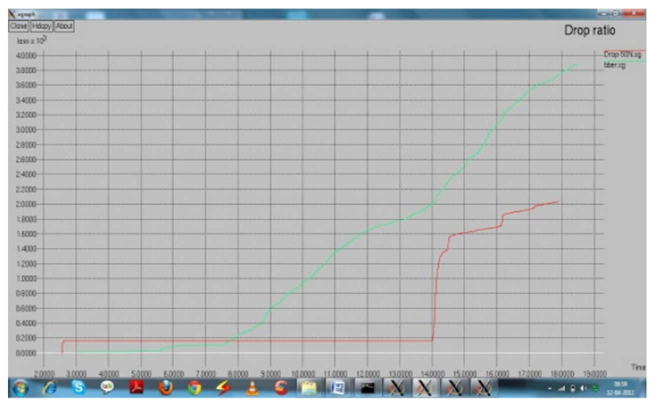
Hierarchical tree structure is used in Efficient Geographic Multicast protocol (EGMP)[13] for the implementation purpose of efficient group membership management. In EGMP, we divide the entire geographic region into zones. These zones are formed virtually. Zone formation does not require much overhead and this is essential for efficient communications over a dynamic MANET. With virtual zone, EGMP need not track each and every node's movement but keeps track of the membership changes in the zones. This improves the robustness and degrades the overhead of the management of the proposed multicast protocol. Construction of the zone structure is independent of the network regions shape. This structure also reduces the topology maintenance overhead. To reduce the flooding overhead and delay present in earlier systems, EGMP supports bi-directional packet forwarding.

Source is identified and it is divided into two as Source and Source-home for better group membership management. Both source and source-home share the same information. They are responsible for electing a zone leader for each of the zones. To facilitate zone leader election, the distance of each node from the source is calculated. The node which is at the shortest distance from the source is chosen as the zone leader. The source sends the data to be multicast to the leader. Zone leader is responsible for multicasting the packets to the nodes in its region. It also updates the details of each and every node present in its region.

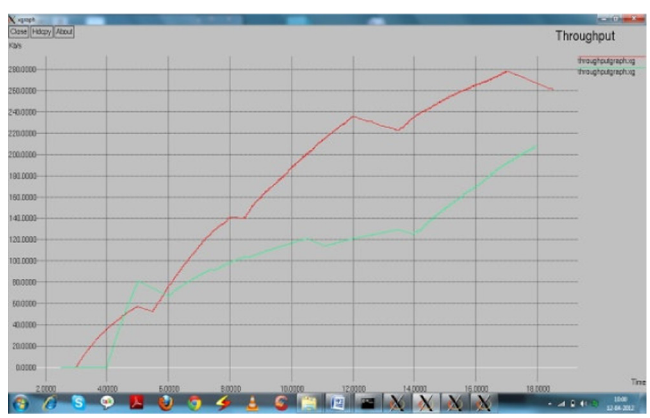
When a node moves from one zone to another, it gets the data from the zone it has moved to. It is the responsibility of the zone leader to keep track of change in group memberships.

7. Simulation Results

The graphs show the comparison of SPBM and EGMP in which Graph 1 shows that the drop ratio of EGMP is lesser than SPBM hence retransmission is reduced and utilization of resource (bandwidth) is increased. Graph 2 shows that the throughput of EGMP is higher than that of SPBM.



Graph 1. Comparison of SPBM and EGMP - EGMP is lesser than SPBM.



Graph 1. Comparison of SPBM and EGMP - EGMP is higher than that of SPBM.

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