CHAPTER 3

METHODOLOGY OF MUTUAL SHARING RANGE DETECTION MULTICAST ROUTING PROTOCOL

3.1 INTRODUCTION

Right from the innovation of communication media, communication among people and devices has evolved in a tremendous way. The communication is carried out by various communication models. Wireless communication itself is carried out in two different ways. One is infrastructure-based mode of communication in which mobile nodes are communicating through a fixed backbone network. The other is infrastructure less model. A MANET is one of the examples of infrastructure less based system model in which nodes have organized themselves and they act as router as well as workstation or host.

Nodes in a MANET do not use centralized administration. A communication session is performed either in single hop if the receiver is within transmission range or by relaying through some intermediate nodes. One of the first ad-hoc wireless networks was the packet radio networks established by Advance Research Project Agency (ARPA) in 1973. Since then numerous studies have been made to upgrade the performance of mobile computing and applications .MANET is also known as multi-hop packet radio networks as nodes in the out of transmission range are communicated through few intermediate nodes Due to absence of centralized control, overhead management of nodes in MANET is one of the biggest tasks.

3.2 OBJECTIVE OF PROPOSED PROTOCOL MSRDMP

When a multicast routing protocol is deployed in an environment, various parameters like the mobility of node, impact of node density, impact of group size and impact of a number of groups are taken into account. These parameters mainly have the impact on the robustness of nodes, scalability and group management. While considering these parameters, the primary objective of the proposed multicast routing mainly focus on packet delivery ratio, control overhead, average end to end path length and average joining delay as analyzed and stated by Xiaojing et al (2010).

3.2.1 Increased Packet Delivery Ratio

The packet delivery ratio or throughput makes a great impact on the performance of a networking protocol. It is essential that the number of packets sent from the source of the node should be delivered to the receiver of the node at maximum level. Amidst high density of nodes, external noise to signal propagation and hidden and exposed terminal problem pose the severe impact to packet delivery ratio. The proposed protocol MSRDMP aims at high packet delivery ratio.

3.2.2 Minimized Control Overhead

Group management, assurance of packet delivery would cause greater impact to the performance of any multicast routing protocol. Control messages usage and updating of information about group members involves a larger work. It is optimum that the number of control messages used in managing the data packets and group members should be low. The proposed protocol aims at using fewer control messages and quick updating of information in dynamic topology so that control overhead associated with delivery of packets is reduced.

3.2.3 Minimized Average End to End Path Length

In a highly mobility environment if the packet sent travels along longer distance or hops between several nodes would cause loss of the packet. The proposed protocol aims at minimizing the average path length of packet travelled.

3.2.4 Average End to End Delay

As far as multicast routing is considered, the node which is not interested to join the group should not be disturbed. The same way the node which is likely to become the member of multicast group should be allowed to join quickly in order to reduce the average joining delay. The proposed multicast routing aims at minimizing the average joining delay.

3.3 DESIGN of MSRDMP

The proposed MSRDMP comes under the category of location aware multicast routing protocol. As far as multicast routing is concerned, group construction is a very important task. The nodes in MANET are mobile in nature and so link stability of one node to another is highly unpredictable. One of the nodes in multicast group acts as a leader or head of the group and takes the responsibility to send the packets to all its members. The main design of MSRDMP is how to manage the group leader of the multicast group and how the group is constructed. Now a day's all kinds of mobile nodes available in the market is well equipped with global positioning systems. Su et al (2001) proposed mobility prediction model using information provided by global positioning system. The group construction of MSRDMP can be understood by contrasting zone based construction from transmission range based construction.

3.3.1 Coalitional Game Theory

Cooperation between mobile nodes can be highly possible by a method known as grouping. The member or nodes in a group can easily communicate one another. Each group has a leader which takes entire responsibility for managing the group. Fatemeh et al (2011) have used game theory to analyze the behavior of nodes in a decentralized or self organizing wireless structure. Game theory models the activities of nodes in a MANET.

According to author a game consist of following terms, A set of nodes N= {1,2,3,……n}. An indexed set of possible actions A= A_1 X A_2 …….A_n . where, A_i is the set of actions of node (for $0< i \leq n$) A set of utility functions, one for each node. The utility function U assigns a numerical value to the elements of the action set A; for actions $x,y \in A$ if $U(x) \geq u(y)$ then x must be at least as preferred as y.

Game theory is of two types namely non cooperative and cooperative game theory. Non cooperative game theory analyze the action held between nodes. This non cooperative theory aims at improving the utility of individual nodes and reducing its cost. Cooperative game theory bothers the merit of all the nodes. It takes responsibility to improve the utility of all nodes. The proposed MSRDMP uses the cooperative game theory to form a group in a deployment area.

In a coalitional game (N,v) with N nodes. The utility of a coalition is calculated by a characteristic function $v=2^N$-R. Here R refers to some rigid restrictions or a single value most coalition games are of transferrable utility type. It means that the utility of a coalition can be distributed between the coalition members.

3.3.2 Zone Based Group Construction

In this information age, many multicast routing protocols have been introduced in modern wireless environment. MANET is in such an environment where node is given a lot freedom to move resulting in dynamic topology configuration at every quantum of tiny time period. Especially in the multicast communication system management of group leader is a crucial task. The group leader is the node which takes the responsibility to send the multicast packet to all its group membership.

The node that joined the multicast group is called member of the multicast group. A node in a group has to address problems like interference, congestion, noise, collisions, fading and so on. Among the protocols introduced, some are location based group construction where the area of the group construction is spawned up to some square meter, even if the transmission range of underlying protocols are limited. Before data packet reaches its intended destination, it has to be forwarded by a few intermediate nodes and hence hop count increases delay. Moreover, when data is being forwarded, it is suffering from high probability of loss due to congestion and density of group size.

It is necessary to know how zone based group construction affects the packet loss by understanding the transmission range group construction. Even though the nodes in location aided protocols are aware of their position, sharing of control messages between group leader and group membership is absent. The robust scalable geographic multicast is location aware protocol introduced by Xiaojing et al (2010) and another location aware protocol scalable position based multicast routing developed by Transier et al (2004). RSGM and SPBM are some protocols designed based on group construction in terms of zones. The diagram in the Figure 3.1 shows zone based group

architecture. The size of the zone is 400 by 400 square meters taken into account in RSGM.

The zone has several groups but managed by only one zone leader. As there is only one zone leader for entire zone, the zone leader has to manage a number of different multicast trees so that each group member of the group can receive the packets. In multicast routing group leader has to send its packet to all the group members which are grouped under one group id. The IEEE 803.11 standards offer its own transmission range; nodes beyond this transmission range could not communicate one another directly without intermediate nodes. The group constructed based on zone would suffer from a lot of problems like packet loss, high control overhead, inability to increase scalability and very difficult group management.

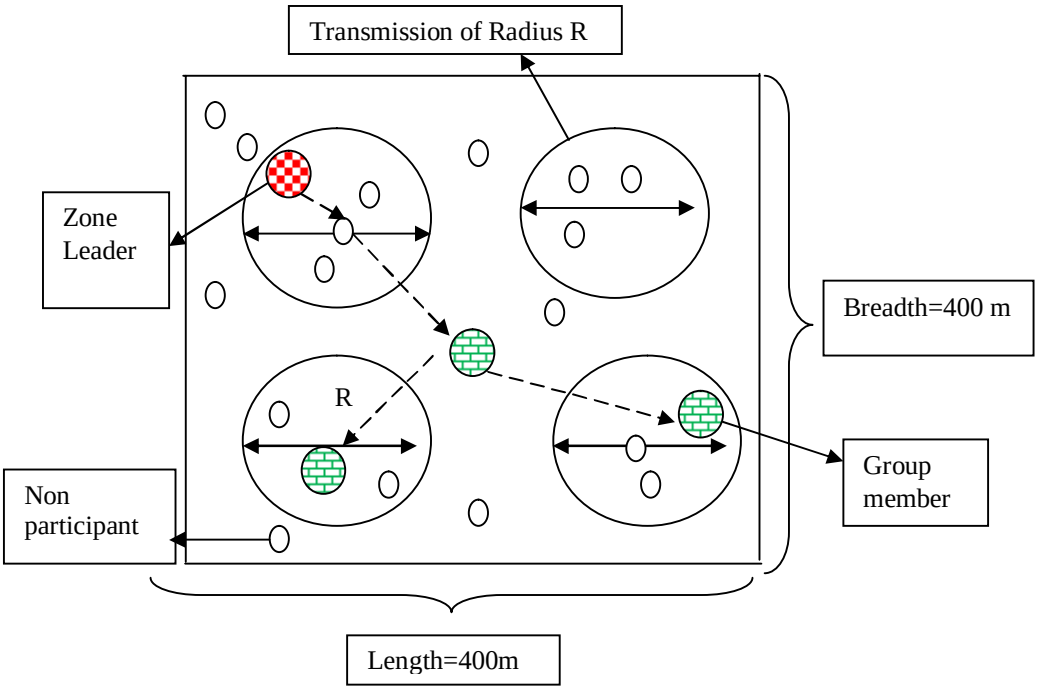

Figure 3.1 Zone based group architecture

3.3.3 Transmission Range Based Group Construction

This thesis report proposes that a new protocol called as mutual sharing range detection multicast protocol. This is also a location aware protocol. Nodes using this protocol are equipped with global positioning system, which is used to guide the group leader in the multicast group. MSRDMP is a table driven tree based multicast protocol in which control overhead is minimized to the optimum level.

In this approach multicast group is constructed based on the transmission range of the nodes with respect to the virtual reference point. Before group is formed virtual reference point is set with respect to the nature of the environment where MSRDMP is deployed. Each node that is interested to take part in multicast group is let know about how far they are away from the virtual reference point using global positioning system. The Figure 3.2 describes how group construction is carried out in MSRDMP. In MSRDMP multicast group is formed in such a way that if the transmission range of a node is R then R/2 radius forms a group.

In transmission range based group construction each group has the radius of half of the transmission range of nodes. In zone based multicast routing protocol there exist only one group leader for the entire zone to manage the group. In MSRDMP the application area, where nodes are deployed is divided into a number of groups. Each group has one Group Leader (GL) and one Leadership Track Node (LTN) and number of Group Member (GM), all other nodes are called the nonparticipant of the group.

The group leader takes the responsibility to send the multicast packet to its entire group member. As group construction is established with respect to the virtual reference point, it is not necessary to construct several virtual reference trees in forwarding the packet to intended group members. A number of groups and number of nodes per group can be increased to the desired level of application area.

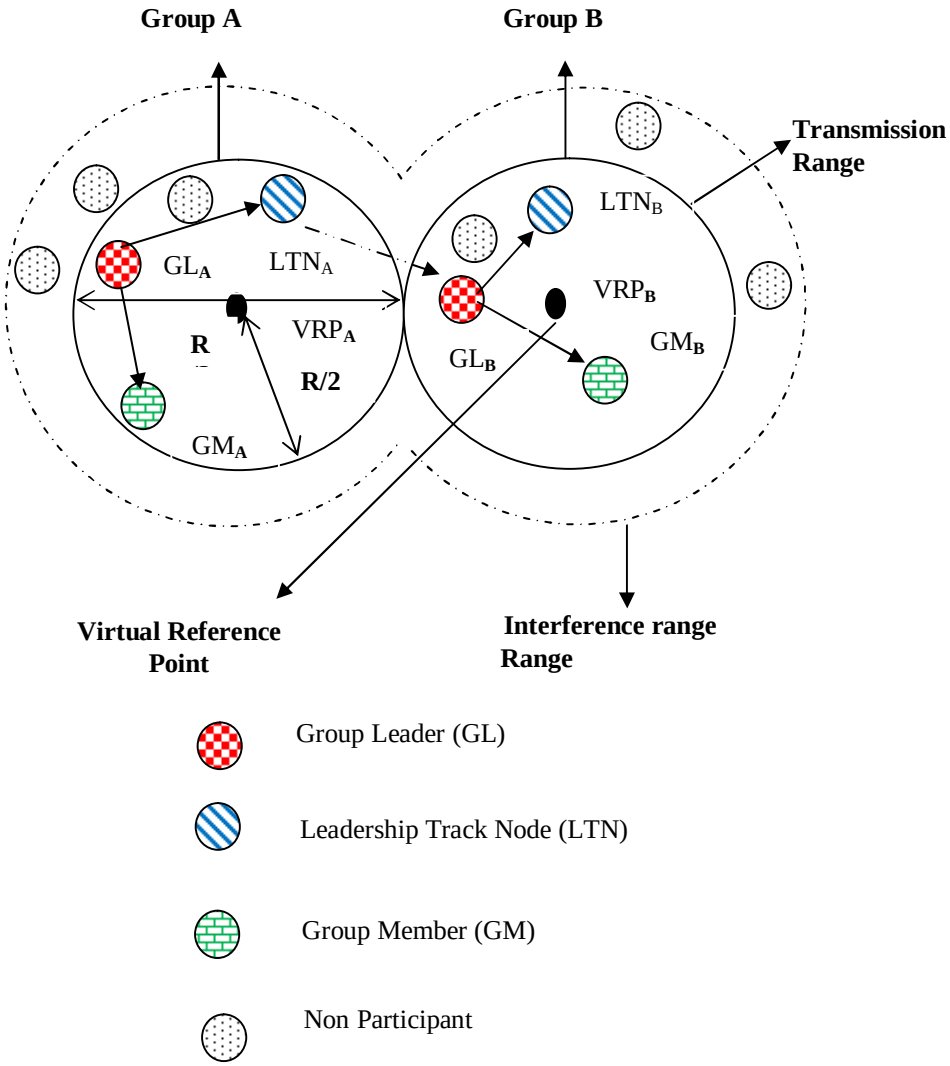

Figure 3.2 Range based group architecture

3.3.4 Responsibility of Leadership Track Node

Leadership track node holds three major responsibilities. The one is to forward the multicast packet to its adjacent group leader and the other responsibility is to send the lost data packet to a victim group member upon receiving the Interim Clear To Send (ICTS) request from the victim group member that has not received the intended data packet already sent by its group leader. The last is to give alert message when group leader moves out of range. The primary objective of our proposed protocol MSRDMP is to provide reliable data transmission of packets.

3.3.5 Table Driven Proactive MSRDMP

The MSRDMP is a table driven approach. Efficient group membership management is carried out with the help of control packets maintained by each node that takes part in group communication. Every node maintains a table. The value of this table is updated now and then in encountering dynamic topology change in the system. They are used to maintain the group membership management and used to share control messages between the nodes. In order to perform effective proactive multicast routing the table maintained by each node is updated whenever the group leader moves out of range or its membership strength is reduced. The Table 3.1 represents data maintained by the individual node, whereas Table 3. 2 shows data maintained by leadership track node.

Table 3.1 Control data maintained by individual nodes

Number of Nodes within a Range of group (NNR)
Number of Group Membership in the group(NGM)
Number of Group member Left the group (NGL)
Address of Adjacent Group leader’s List (AAGL)

Table 3. 2 Control data maintained by the leadership track node

Number of Nodes within a Range (NNR)
Range Limit of Group Leader (RL)
Address of the group the leader for whom Leadership track acts(AGL)
Address of Adjacent Group leader's List (AAGL)

3.3.6 Incorporation of GPS Value with IPv4 Header Format

The IPV4 datagram format with GPS information is shown below in the Figure 3.3. Here in MSRDMP protocol uses the option field to update the information about the distance determined by GPS. As stated each node is equipped with GPS, which monitor the distance from the virtual reference point. When the message is multicast by the group leader, this information about distance is also padded with a datagram. Before the connection is established, leadership track node stores original distance of group leader which is denoted by Do=R/2, where R is the transmission range of the node. Due to the mobility of group leader, distance changes and the same are calculated by GPS and denoted by Dc. This Dc value is the current distance of the group leader from the virtual reference point. Leadership track node makes use of this information to calculate the cutoff range. This cutoff range is defined as the differential distance calculated by subtracting current distance from its original distance from the virtual reference point. The cut off range is denoted by Cr and calculated as expressed in Equation (3.1).

$$C_r = D_o - D_c \tag{3.1}$$

<table>
<tr><td>VER 4bits</td><td>HLEN 4bits</td><td>Service 8bits</td><td colspan="2">Total length 16 bits
DATA</td></tr>
<tr><td colspan="3">Identification 16 bits</td><td>Flags 3 bits</td><td>Fragmentation offset 13 bits</td></tr>
<tr><td>Time to live 8 bits</td><td colspan="2">Protocols 8 bits</td><td colspan="2">Header Checksum 16 bits</td></tr>
<tr><td colspan="5">Source IP Address 32 bits</td></tr>
<tr><td colspan="5">Destination IP address 32 bits</td></tr>
<tr><td colspan="5">Information about distance obtained by GPS</td></tr>
</table>

Figure 3.3 IPv4 Header format with GPS information

3.3.7 Shared Tree Architecture

In a tree structured multicast routing architecture, there exists only one path between source and destination. In case of mesh structured multicast routing there exists multiple number of paths between source and destination. The mesh based architecture suffers from path discovery problem in selecting either this or that paths as there are more number of paths and consequently increase the delay of packet delivery. In tree based architecture packet loss is high as there exist only one path.

This proposed MSRDMP introduces the shared tree architecture where group leader and leadership track node share the control messages in delivering the data packets and alert messages. Xiaojing et al (2010) analyzed a virtual reverse-tree based structure in constructing multicast group in RSGM. RSGM follows the tier architecture where the upper layer informs the information about group to group at lower levels. In case of MSRDMP each group updates the information about group periodically and shares with the help of the leadership track node.

3.3.8 Distinguished Initialization and Maintenance Mechanism

The proposed MSRDMP is neither a sender initiated nor a receiver initiated, but comes under the category of distinguished initialization. By this approach at the time of sending a packet to its entire multicast group it acts as source initiated. Once the packet is sent, then the receiver takes responsibility to acknowledge the received packet. As it performs activities of both senders and receivers this approach is distinguished from a normal kind of initialization. There are two kinds of maintenance mechanism, namely hard state and soft state. In hard state protocol the state of the protocol remains unchanged until it is managed by a retransmission or reliable acknowledgements. In the soft state routing protocol routing information is updated automatically with respect to topological changes of the network. The information about the network is cached periodically and refreshed by the end hosts. The proposed MSRDMP employs the soft state protocol method.

3.4 SIMULATION TOOL AND SETUP

The MSRDMP is implemented with the help of the Global mobile simulation library. The simulation is run with 300 nodes randomly in the area of 1000 m ×1000m and node moving at a speed from 5 to 30 meters per second. The MAC protocol and radio parameters are fixed according to the Lucent Wave LAN card that operates at a 11 Mbps and radio frequency 2.4 GHz and transmission range is 250 meters. MAC protocol that has been used for this simulation is 802.11bDCF. Each simulation lasted 500 simulation seconds. Each group leader sends Constant Bit Rate (CBR) data packets at 8Kbps with packet length 512 bytes. Based on the model assumption and the help of a GPS system MSRDMP protocol provides good result so that it can be applied to various emergency group communication systems

3.5 SUMMARY

In this chapter newly proposed protocol MSRDMP is introduced and objective of that protocol is to be met is discussed. The objective of MSRDMP focuses on four important performance measure packet delivery ratio, control overhead, average path length and joining delay. The way group constructed in multicast routing determines the performance of the protocol. The difference between range based group construction and transmission range group construction is explained. How to design the MSRDMP is explained and how group construction of MSRDMP is differed from RSGM is discussed. The chapter tells that MSRDMP is table driven multicast routing protocol, which employs the shared tree architecture and distinguished initialization and soft state route maintenance.