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ENHANCED MSRDMP FOR SECURED SCALABILITY FOR MANETs

R.VELUMANI*[1] and K. DURAISWAMY[2]
Department of CSE, K.S.R. College of Engineering Namakkal, Tamilnadu, India*[1]
K. S. Rangasamy College of Technology, Namakkal, Tamilnadu, India [2]

ABSTRACT

Extending the scalability to network size and group member size poses several problems in multicast communication. Group leader in multicast group is to be capable of accepting the members from another group as well as identifying the intruder that tries to join the group. The enhanced MSRDMP provides the method that supports legitimate group members to join the group using transit hello packet. The transit hello packet is one of the location marking packets that has the information about where the members are at present. The group leader in newly generated group passes its location information to other existing group through appendix packet. The intruders are identified using the transit hello packet, and appendix packet in enhanced MSRDMP. The enhanced MSRDMP provides the way to construct secured scalable multicast communication for MANETs. The performance of routing protocol is analyzed comparing three location aware protocols RSGM and SPBM.

Keywords: Appendix Packet; MANETs; Multicast routing; Scalability; Transit Table; Transit hello packet.

1. INTRODUCTION

Communication is sharing of thoughts or information from one subject to another subject. The subject may be a human being, animal or birds, even it can be a tree. The recent research survey says that trees are communicating one another. Very long ago human beings were communicated very first through drawing an image or picture on a rock. They used some kind of sounds like birds and animals are producing now. Later sounds got evolved into a natural language when they were capable of writing a symbol or script for a particular sound. The people at a hand stretch distance communicated directly. A various forms of communication used to convey the information to a remote location. The marathon was one of the examples of remote communication. Ancient kings used pigeons to carry the message from one region to any other region, which was far away from where they used to live. Day by day, human culture, tradition and civilization had changed so postal service, telegram, radio and television are used for communication. In this information age the way information shared among people is very wonder, the most appreciated invention is computer and one of its major application is the internet. Because of the internet the world is called global village where people are very close to one another. The internet is defined as the network of networks in which all computers can be connected to each other. In many occasion group communications plays a vital role. The group communication is also called multicast communication. This is applied in a video conference, group game guidance and military application and so on. The communication through computer network can be done by two modes, namely wired communication and wireless communication. The MANETs comes under infrastructure less wireless communication in which no access point is used between sender and receiver. The multicast communication in MANETs poses several issues such as robustness, routing, scalability and etc.

2. RELATED WORK

Several protocols have been proposed to address the robustness and routing in multicast routing. Xiang *et al* [1] proposed that RSGM is a location aware multicast routing protocol. It follows effective group membership management using two- tier architecture. At the lower tier a zone construction is built based on position information and a leader is selected for that zone. The leader manages the group membership and gathers the position information of each member in the group. In the upper tier the group leader informs the membership about the source of multicast group using virtual reverse based tree structure. If group leader does not know the address or position of the source then it will get it from source home. With the help of member zones the source forwards the packet to zones that have group members along the virtual tree rooted at the source. Once the packet has been arrived at a member zone, then the group leader takes responsibility to forward the packet to all local group members along virtual tree rooted at the group leader. The SPBM[2] is the location aware protocol, which explained the role of the group leader for bigger zone, the group leader maintains predefined tree structure that manages the members of the group. The data packet is forward in positioned based unicasting as described in [3].Two nodes in multicast routing are communicating when distance become less than some fixed point using distributed algorithm [4]. Among the protocols MSRDMP is one of them and under the category of location aware multicast routing protocol. In MSRDMP the multicast group is constructed based on virtual reference point. In MSRDMP the zone is divided into a number of groups based on the transmission range of nodes deployed in the environment. The existing protocol MSRDMP [5] only deals with how robustness is achieved in multicast routing . When network size increases problems with scalability greatly affects the performance of the routing protocols. The enhanced MSRDMP deals with how secured scalable group construction carried out in the multicast group communication.

3. The ENHANCED MSRDMP FOR SCALABILITY

The proposed approach is the enhancement of the existing protocol MSRDM for secured scalability in MANETs. When a multicast group is increased, the information about the new group should be made known to other existing group. The group member may shift from one group to another group in the dynamic environment. The protocol must provide the security to isolate the intruder or stranger node in the area where nodes are deployed for proper communication.

3.1 Need for Scalability

The nodes operated in MANETs do hardly place or stay in the same location because they are in dynamic topology. As far as multicast communication is concerned in mobile environment, the group member of the group often changes its location subsequently it jumps from one group to another. The node jumped from one group to another should be carefully managed and be allowed to join the new group. In many situations it will become very essential that a number of groups should be increased to achieve the effective group communication. When a new group is constructed it should be let known by other existing groups. The devised protocol for multicast routing should be capable of allowing the group members to join the new group and also capable of increasing the number of groups. Increasing the number of groups and the number of group members per group do not affect the performance of the system. The proposed MSRDMP ensures that effective packet delivery ratio and minimized control overhead and joining delay.

3.2 Role of Transit Table for Scalability

The proposed MSRDMP is the location aware table driven protocol, each node maintains few tables for maintaining control data by individual nodes and leadership track node. The descriptions of these tables are used as designed in Leadership Endurance Prudential Mutual Sharing Multicast Routing [5]. In order to achieve the effective scalability in multicast routing, MSRDMP maintains one more table named Transit table. This transit table maintains and updates the information about virtual reference point. Before group is constructed a virtual reference point is set in the area. The number of the virtual reference point set depends on the size of the area and transmission range of mobile nodes. The virtual reference point (VRP) refers to a location in the area and acts as a center of radius for a particular group. If the range is R then R/2 of range from the virtual reference point forms the radius of the particular group. The Figure 1 shown below depicts the number of groups in a particular area. To avoid confusion in understanding, only few nodes are drawn inside the each group. In fact, each group contains a number of group members (GM, one group leader (GL), one leadership track node (LTA) and may contains many numbers of non participating nodes. All nodes maintain the transit table, including non participant node. The figure 2(a) depicts the empty format of transit table. This transit table maintains a stack which stores the information about virtual reference point. If there are four groups then four values of virtual reference point would be stored in the transition table. The top pointer in a stack always holds the information about the virtual reference point with which a node has currently become a membership of the group. Once a virtual reference point is set in the area the information about the VRP is made known to all nodes. The figure 2(b) shows the transit table for all nodes. After leader for each group is selected by invoking the persistence, leadership algorithm, each node in the group updates stacks of transit table. For instance the figure 2 (c) represents the transit table for group member GM_C for group named C. Clearly the top of the stack points to VRP_C because GM_C is the group member of group C and the group C is constructed with respect to virtual reference point VRP_C.

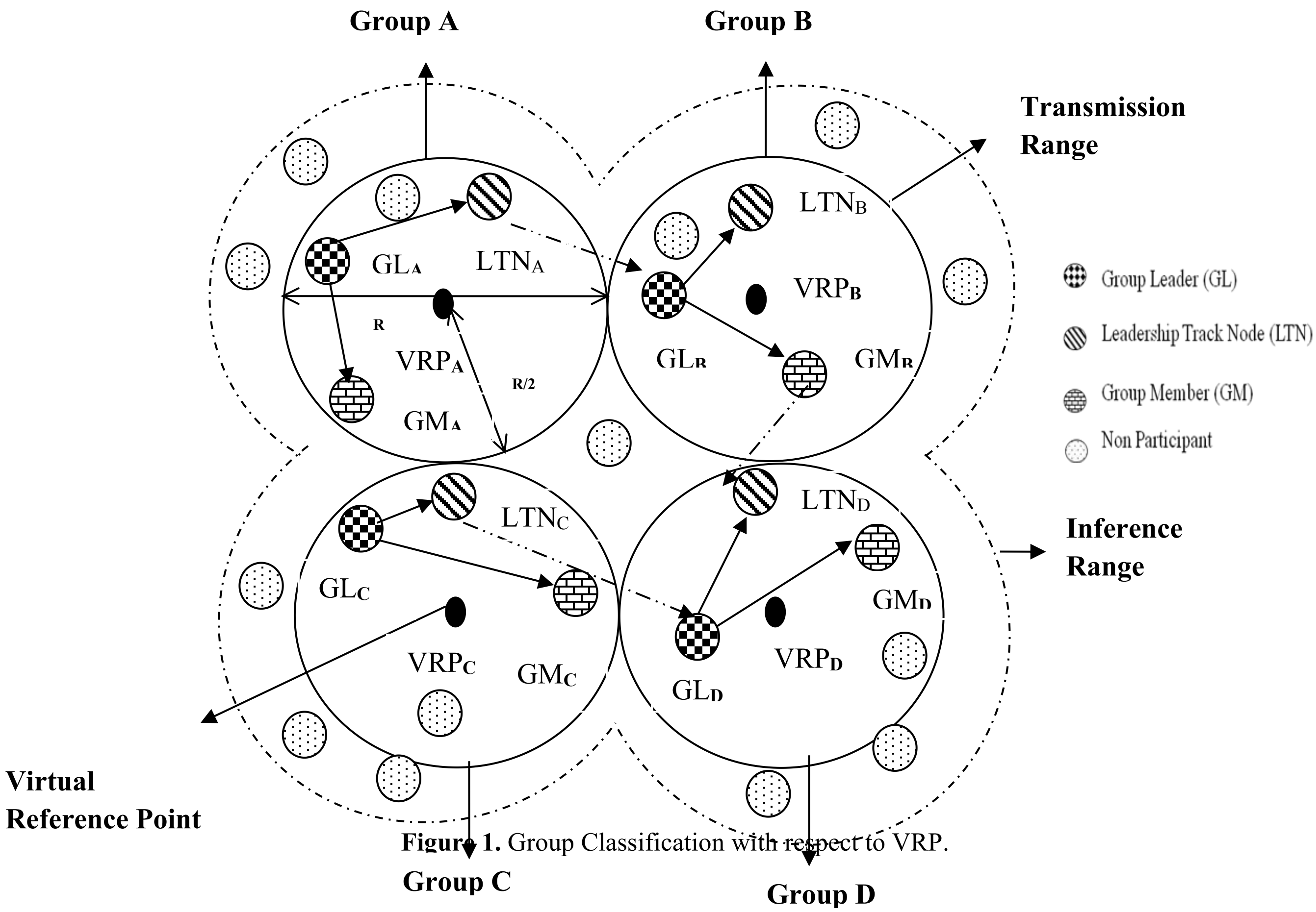


Figure 1. Group Classification with respect to VRP.

VRP$_1$
VRP$_2$
VRP$_3$
VRP$_4$
.
.
.
.
VRP$_N$

VRP$_A$
VRP$_B$
VRP$_C$
VRP$_D$

(a)
(b)

VRP$_C$
VRP$_A$
VRP$_B$
VRP$_D$

(c)

Figure 2. (a) Empty Transit Table (b) Transit Table before selecting GL (c) Transit Table of group member GM$_C$ for Group C

4. SECURED MIGRATIONS BETWEEN GROUPS

As it is stated earlier group member of one group may move to another group either deliberately or accidentally. After the group member migrated to a new group, it may not be communicated with its old group leader if it moves away from transmission range of old group leader. In such a situation the migrated group member would become a non participant node of the new group to which it has moved recently. If the migrated group member wants to take part in multicast group communication, it may flood a transit hello packet in the new group. The transit hello packet holds the information stored in the transit table. Upon receiving the transit hello packet leadership track node of the new group would come to know that the group member has migrated from some group and its previous or the old group is identified by looking at top point of the stake of the transit hello packet.

4.1 Isolation of intruder

The group members that have migrated to new group must have to send the transit hello packet to become the member of the new group. The non participant node would also migrate from one group to another group. The Enhanced MSRDMP identifies the node if it is migrated from another group or it is a non participant node on receiving the transit hello packet. Looking at top stake pointer, the migrated node can be identified from where it has migrated. If the migrated node does not possess the transit hello packet, MSRDMP ensures that it is the intruder that exploited the group construction and the node is not allowed to become the group member of that group.

4.2 Stale THP packet

Some nodes in the deployment area have not become the members of any group after the groups have been formed. They are said to be non participant nodes and would become the members of some group later using the stale transit hello packet. The stale transit hello packet do not have a top stake pointer, but the stake is filled with the information about virtual reference point.

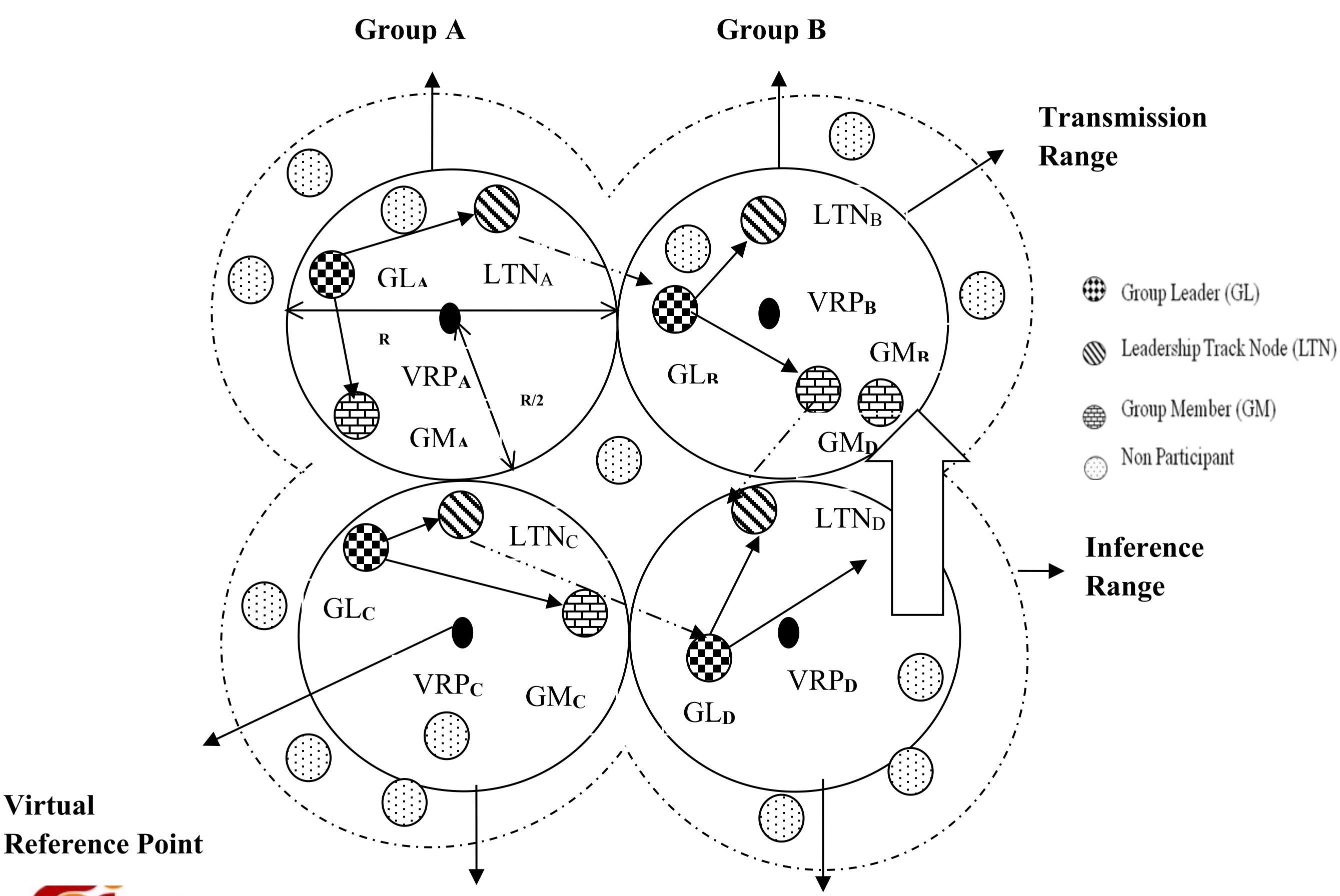


Figure 3. Member migration from group D to Group B.

Once migrated node sent the transit hello packet leadership track node of that group makes a decision on whether to reply with address of the group leader of that group or not. If number of group members in that group does not exceed the permitted threshold value already set, leadership track node would reply the transit hello packet with the address of the group leader for that group. Then the migrated group member makes use of the address of the group leader and would send joint request JR to group leader and become the new group member of the group after receiving the acceptance reply (ARY) from the group leader. Figure 3 represents migration of group member from the group D to the group B. The group member GM_D is said to be migrated node after it reaches the group B. To become a group member of the group B, it has to flood the transit hello packet, after replied by the leadership track node of the group B, it would become the part of the group member of the group B after its join request is accepted by the group leader GL_B. Once it becomes the group member of the group B, it alters the transit table so that the top pointer of the stake points to virtual reference point VRP_B. The MSRDMP protocol paves the way that any stranger node or the node which has not been deployed during group construction can't take part in group communication. The node only posses the transit table is allowed to join the any group while moving between the groups.

4.3 Secured Scalable Algorithm

The group member that migrated from one group to another can invoke the secured scalable algorithm to become the group member of the migrated group. The algorithm uses some notations and they are described below

R	Transmission range of a node
JR	Joining request
ARY	Acceptance Reply
N_i	Group member that migrated from any group
VRP_i	Virtual reference point for current group
VRP_j	Virtual reference point for migrated group
LTN_j	Leadership track node for migrated group
NGM_j	Number of current group member for migrated group
GL_j	Group leader for migrated group
GM_j	Group member for migrated group
TSP	Transit stack pointer
THP	Transit hello packet
TT	Transit Table
Threshold	The maximum group member can be handled by GL_j

BEGIN
If (N_i>R/2) from current VRPi then
N_i sends THP to LTN_j
LTN_j checks if NGM_j < Threshold
LTN_j sends GL_j address to N_i
N_i sends JR to GL_j
GL_j sends back ARY to N_i
N_i== GM_j
AddNodetoMcasttable (pkt.groupid, GM_j.id)
GM_j alters TT and TSP points to VRP_j
END

5. NEW GROUP CONSTRUCTION

In order to stretch the communication to longer distance, a new group can be constructed and attached to the existing groups. To construct a new group it is necessary to set a new virtual reference point. The information about the new virtual reference point should be made known to all the nodes in the entire group. It is meant that all nodes have to update the transit table. This transit table is used to generate the transit hello packet and help the group member, join the any group in the deployment area. The figure 4 represents new group construction with existing groups, in which the VRP_E refers to the new virtual point set to construct the new group E. When the new group is constructed transit table of all the nodes in the group E are updated with the information about the existing virtual reference point along with new VRP_E.

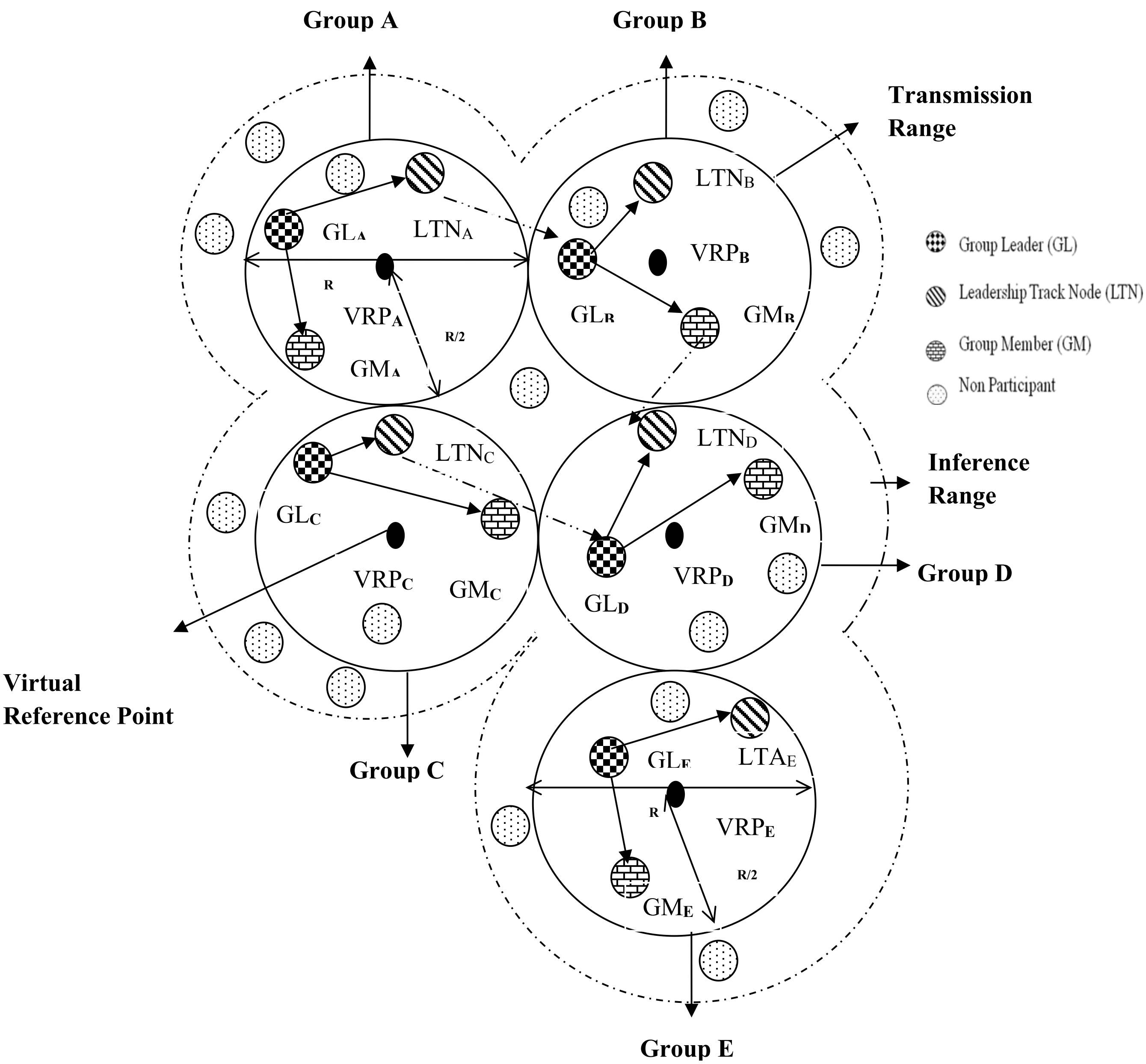
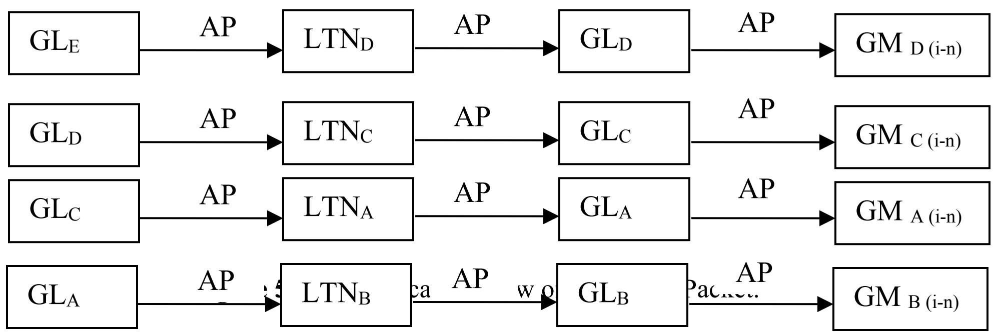


Figure 4. New group construction with existing groups.

5.1 Role of Appendix Packet

The nodes in the existing group are not aware of the new group E unless they are informed by some way. The MSRDMP does not allow the nodes which do not have transit table value. The group leader GL_E of new group first inform about VRP_E to its neighbor group via leadership track node of that group. For the group E, the group D is a neighbor, the GL_E informs about VRP_E to LTN_D by sending an appendix packet (AP). The appendix packet is an informative packet that carries the information to the neighboring station about newly set virtual reference point for a new group. Once LTN_D receives the appendix packet, and it updates its transit table and passes the appendix packet to its group leader GL_D. After GL_D receives the appendix packet, it multicast the same to all of its group member $GM_{D\ (i-n)}$. The serial way of communication takes place until all the nodes in the existing group is aware of the new group. The figure 5 shows how appendix packet travels in informing the new virtual reference point.



The group leader of the new group initiates the passing of appendix packet to its neighborhood group. The group leader chooses a destination group in such a way that the LTN of the group has been just adjacent to it. The group leader of each group passes the appendix packet in the same way as the group leader for new group carried out. In the new group E shown in figure 5, the GL_E initially passes the appendix packet to LTN_D of group D. The group D is very adjacent to the Group E. The group leader GL_D may choose its LTN from either the group B or the group C. If GL_D has chosen the LTN from group C, the GL_C chooses the LTN of group A as its next destination instead of the one from group B after the appendix packet reaches at the group C because the group B is not directly adjacent to the group C. This kind of passing avoids ambiguity in transforming appendix packet to existing groups.

6. RESULT & DISCUSSION

The protocol MSRDMP designed for multicast ensures the scalability in increasing the number of nodes within a group as well as increasing the number of groups in a particular environment. In this performance evaluation, the proposed MSRDMP is compared with RSGM and SPBM. These three are location aware multicast routing protocols. Groups in these protocols are formed with respect to position. Every node uses these protocols is equipped with Global Position System. In order to compare the result performance data set for RSGM and SPBM are extracted from a manuscript titled stateless multicasting in mobile ad hoc networks written by Xiang et al [1].

The Global mobile information system simulation tool is used to implement the MSRDMP as suggested by UCLA Parallel Computing Laboratory [6]. The MAC protocol and radio parameters are configured 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 CBR data packets at 8Kbps with packet length 512 bytes. Among three location aware protocols, the MSRDMP produces very good results and it can be applied to various emergency group communication systems. The following metrics were studied to show the scalability of MSRDMP under varying group size and number of groups..

1. Packet delivery ratio: It is the ratio between the number of packets received and the total number of packets sent.

2. Normalized control overhead: The total number of control messages transmitted divided by the total number of received data packets

3. Average Path length: The average number of hops traversed by each delivered data packet.

4. Joining delay: the time interval between a member joining a group and starts receiving of the data packet from that group after becoming the member of the group.

Table 1. Simulation Parameters

Area Size	1000X1000m^2
Number of Nodes	50-500
Average Speed of Node	5-30 km/hr
Number of senders	2/Group
Number of receiver	25 to 150 per Group
Packet size	512 Bytes
Transmission Range	250m
Transmission Rate	54 Mbps
MAC Protocol	802.11b DCF

6.1 Impact of group size

In the dynamic environment the number of group members in a multicast group can't be same for a longer period of time. The nodes are moving between the groups. Every multicast group supports some number of group members. If the number of group members increases, there must be a performance variable in the functionality of the group. The table 2 represents the data set against packet delivery ratio Vs group size. The group size varies from 25 to 150 group members per group. All protocols show good packet delivery ratio, while increasing the group members per group. The SPBM gives very minimum packet delivery ratio when a number of group members per group are low. The graph shown in the figure 6 clearly represents the performance curve for packet delivery ratio. The blue line for MSRDMP flows above the yellow for SPBM and brown for RSGM.

Table 2. Packet delivery ratio Vs Group Size.

Group Size	Packet Delivery Ratio %		
	MSRDMP	RSGM	SPBM
25	97	96	74
50	98	96	84
75	98	96	85
100	99	97	87
125	99	97	88
150	99	98	89

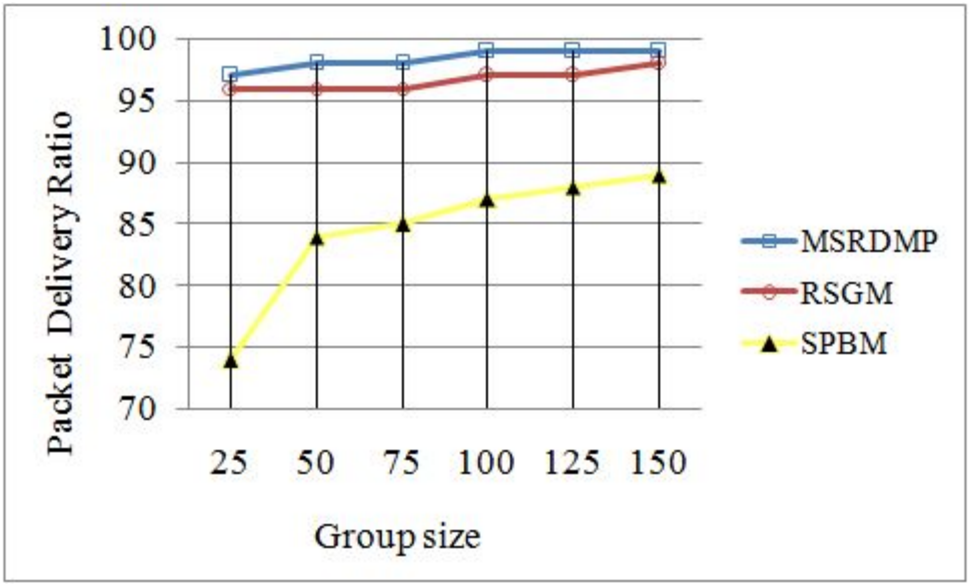


Figure 6. Packet Delivery Ratio Vs Group Size

Table 3. Control overhead Vs Group Size.

Group Size	Control Overhead		
	MSRDMP	RSGM	SPBM
25	5	6	30
50	5	5	12
75	3	4	10
100	2	2	9
125	2	2	9
150	1	1	8

The table 3 showcases the data set against control overhead Vs Group size. SPBM incurs higher degree of control overhead than RSGM. SPBM floods the join query message periodically it is of no use when group size is low. RSGM uses multilevel control message, it produces unnecessary control overhead when the fewer zone leader is available. The MSRDMP uses very few control messages in assisting the node to become the member of the group and transferring the data packets to group members that already became the members of the group. The graph shown in figure 7 indicates the line flow for three protocols. The yellow line for SPBM flows downwards when the group size increases. The red line for RSGM and the blue line for MSRDMP coincidences each other when group size increases. In MSRDMP there must be a group leader in every group, control messages are easily passed in managing the group members.

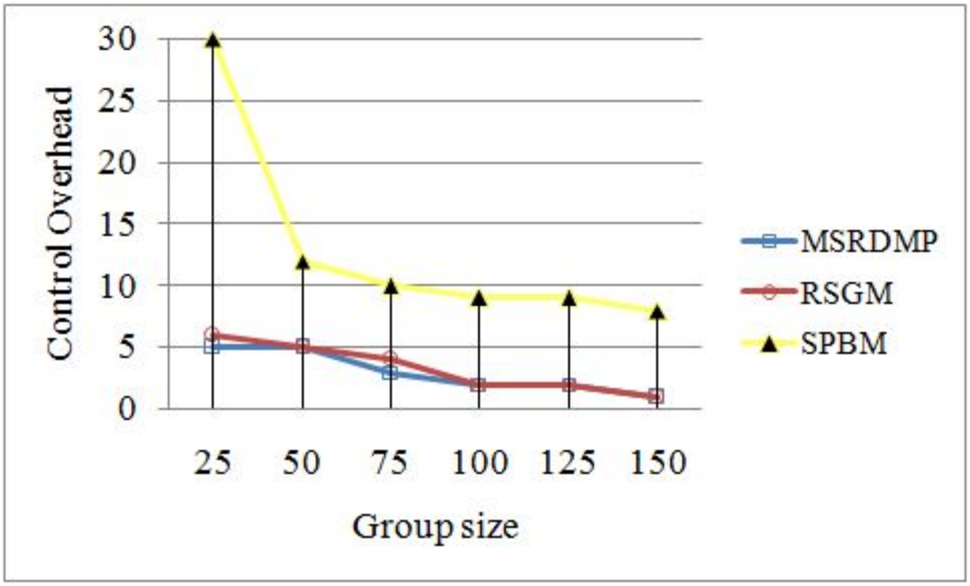


Figure 7. Control overhead Vs Group Size.

Table 4. Average Path Length Vs Group Size

Group Size	Average Path Length		
	MSRDMP	RSGM	SPBM
25	4.2	6.1	6.65
50	4	6.3	6.7
75	3	6.32	6.83
100	2.2	6.4	6.9
125	2.1	6.1	6.9
150	2	6.1	7

The table 4 accommodates the data set against average path length Vs Group size for three location aware protocols. RSGM and SPBM give almost equal average path length. In SPBM zone is divided into a number of groups with hierarchical level. The information passed from one group to another is first transferred to its adjacent group level and later transferred to the top level group, this results in significant increases in path length. In MSRDMP path length is confined to optimum level only if data losses occur the number hops taken by a data packets increase. Each group leader is assisted by a leadership track node in transferring the data packets to its adjacent group. The graph depicted in figure 8 shows average path length for each protocol. The blue line for MSRDMP flows down when group size increases. The brown and yellow line travels almost parallel to each other when group size increases.

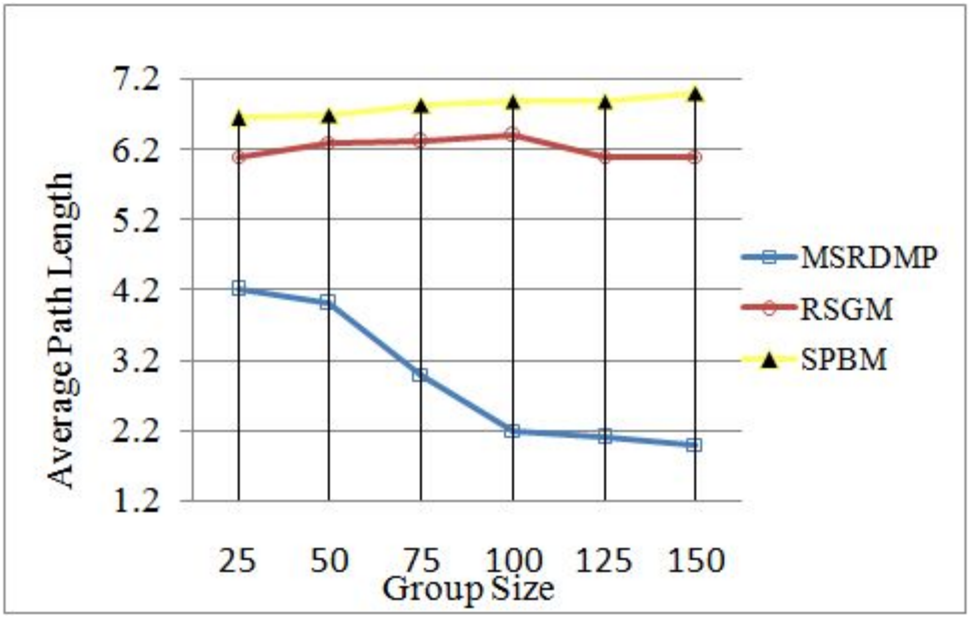


Figure 8. Average Path Length Vs Group Size.

Table 5. Average Joining Delay Vs Group Size.

Group Size	Average Joining Delay		
	MSRDMP	RSGM	SPBM
25	1.5	1.7	11.9
50	1.3	1.5	11
75	1.1	1.4	9.9
100	0.9	1.2	6.5
125	0.8	1.1	6.9
150	0.9	1	7

The table 5 shows the data set against average joining delay Vs Group Size. The average joining delay for SPBM is more when group size increases. Number of zone leader is low when group size decreases. The node wants to become a group member has to wait for long time a number of leaders is low. If the group size increases the joining delay will decrease because the membership would become stable in the larger group size. In MSRDMP the joining process is assisted by leadership track node. In RSGM refresh message is often conveyed to zone leader, the leader position is piggybacked so that new member can easily join the group. The graph shown in figure 9 depicts the line flow for three protocols. The blue line for MSRDMP travels just below the brown for RSGM. Among three protocols the MSRDMP incurs very optimum joining delay for the new member joining the group.

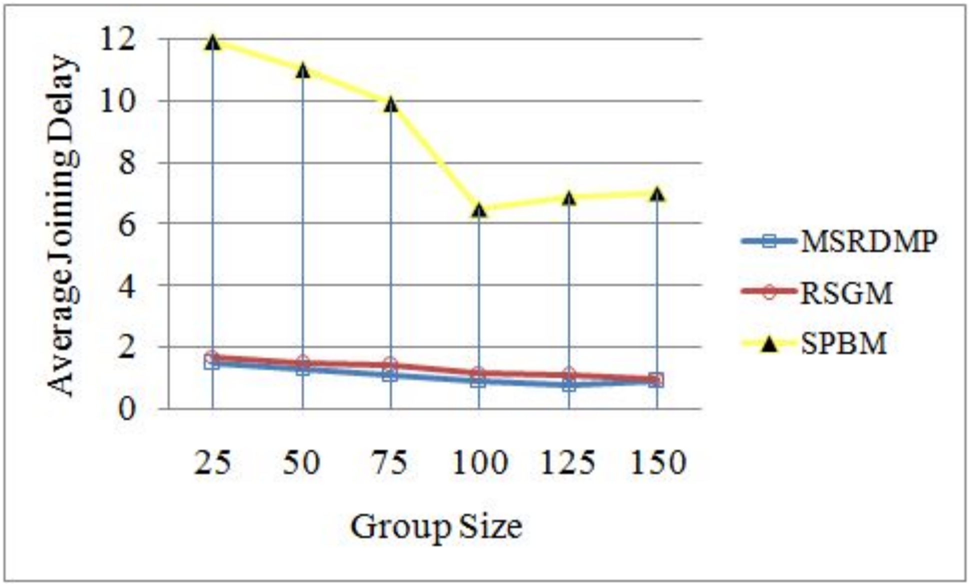


Figure 9. Average Joining Delay Vs Group Size.

6.2 Impact of the number of groups

When network size increases, whole area can't be covered by fewer groups. It is necessary to scale the number of groups so that nodes deployed in the area can communicate each other. The protocol designed for multicast routing should be capable of offering scalable to the number of groups. The MSRDMP is very much scalable to the number of groups. To analyze the impact of the number of groups, the number of the group increases from 2 to 12 groups in the network area and total number of members are fixed as 120. If the number of groups is 2, the number of members per group is 60. If the number of groups is 4, then the number of members per group is 30. The table 5.6 shows the data set against packet delivery ratio Vs number of groups. The packet delivery ratio for all protocols diminishes when the number of the group increases. The SPBM gives a very low delivery ratio only 62% when the number of groups is 12. The MSRDMP gives better packet delivery ratio than RSGM when the number of groups is 12.when the amount of group increase the control overhead as well as the packet transmission overhead increase therefore the packet delivery ratio decreases for all location aware protocols. The graph shown in figure 10 represents the performance of packet delivery ratio. The blue line for MSRDP flows above the lines for RSGM and SPBM. The yellow line falls drastically down when the number of the group increases.

Table 6 Packet Delivery Ratio Vs Group size

Number of Groups	Packet Delivery Ratio		
	MSRDMP	RSGM	SPBM
2	99	97	85
4	98	96	80
6	98	95	68
8	97	94	65
10	96	93	64
12	95	92	62

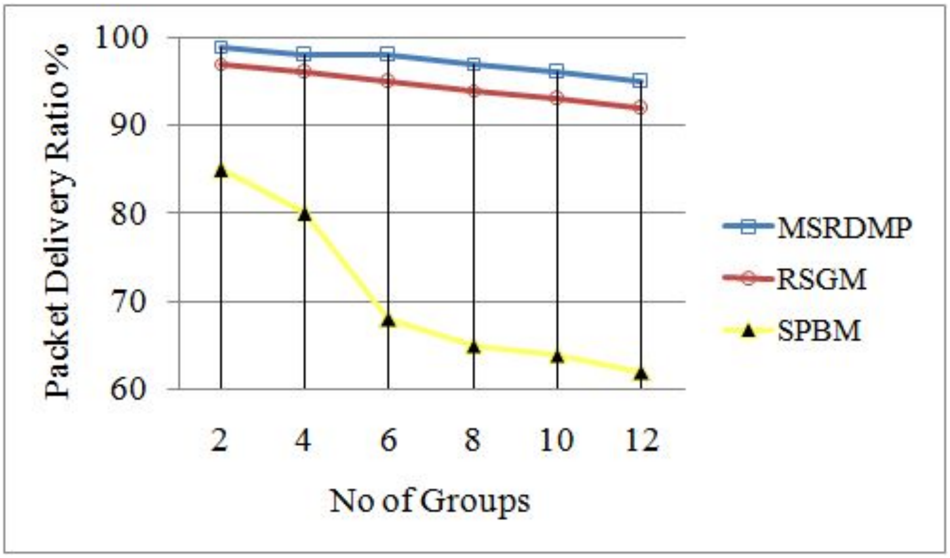


Figure 10.Packet Delivery Ratio Vs Number of Groups.

Table 7 Control Overhead Vs Number of groups

Number of Groups	Control Overhead		
	MSRDMP	RSGM	SPBM
2	0.8	0.9	5.7
4	0.9	1	6
6	1	1.1	8
8	1	1.2	8.2
10	1.2	1.3	8.4
12	1.2	1.5	9

The table 7 presents the data set against control overhead Vs number of groups. All protocols exhibit the higher control overhead when number of group increases. The number of groups is 2, the 60 members per group poses the low control overhead because fewer exchanges of control messages are passed within the members of the two groups. When the number of groups increases the group members are also sparsely deployed hence control messages can be dropped. The SPBM incurs the very high control overhead because the control message has to be passed in predefined tree structure only. In RSGM only zone leader takes responsibility to ensure the membership criteria in a group, whereas MSRDMP makes use of leadership track node per each group, it subsequently reduces the control overhead. The graph shown in figure 11 clearly portraits that the performances curve for control overhead. The control over head for RSGM and MSRDMP is more or else the same. The blue and brown lines overlap each other. The yellow line for SPBM goes upward when the number of the group increases.

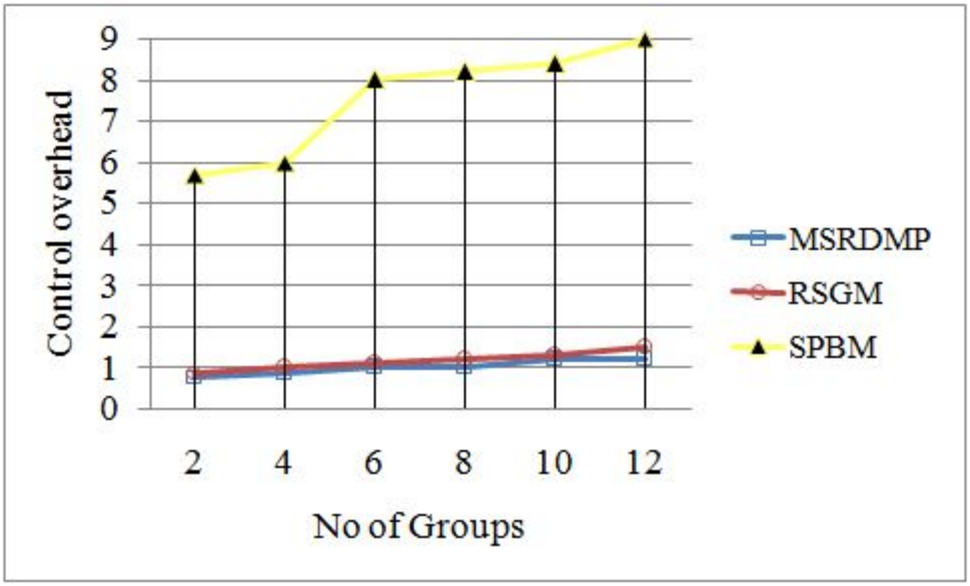


Figure 11.Control Overhead Vs Number of Groups.

Table 8 Average joining delay Vs Number of groups

Number of Groups	Average Path Length		
	MSRDMP	RSGM	SPBM
2	4.3	6.1	7.4
4	4.2	6.2	7.3
6	4	6.3	7.6
8	4.1	6.3	7.6
10	3	6.2	7.4
12	3.1	6	7.3

The table 8 reads the data set against average joining delay Vs number of groups for three multicast routing protocols. The average path length is almost constant for each protocol when the number of the group increases. The RSGM and SPBM incur more average path length than MSRDMP. The increasing in a number of groups makes a little effect on the average path length. A leadership track node in MSRDMP helps the adjacent group leader so that the average path length is low compared to RSGM and SPBM. The graphical representation showed in figure 12 displays the line flow for three protocols. The blue line for MSRDMP goes below the lines for RSGM and SPBM. Among three protocols SPBM incurs high average path length when increases the scalability in terms of number of groups.

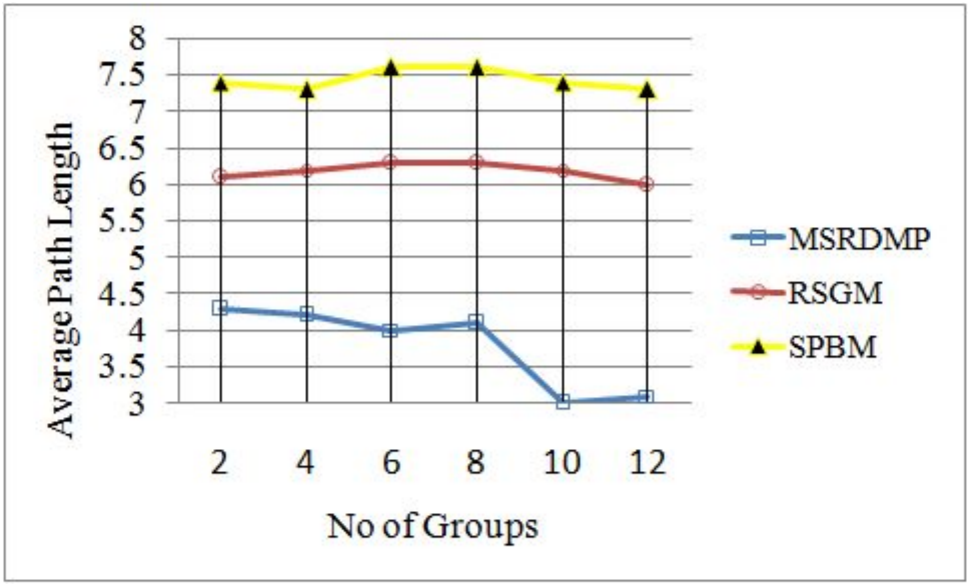


Figure 12. Average path length Vs number of groups.

Table 9 Average Joining Delay Vs Number of Groups

Number of Groups	Average Joining Delay		
	MSRDMP	RSGM	SPBM
2	0.9	1	10.1
4	0.8	1	12
6	0.9	1.7	12
8	1	2	12.2
10	1.4	1.6	14
12	1.2	1.7	15

Table 9 is filled with data set for average joining delay Vs Number of Groups. The joining delay for SPBM increases drastically when the number of the group increases. The joining query is usually managed by the group leader of the group in SPBM. There is more number of group members per group, but only a few group leaders could not manage the entire joining query made by the newly joining node. This leads to extreme delay in joining the group. The joining delay for MSRDMP and RSGM is considerably low when the number of the group increases. In MSRDMP the new node is helped by a leadership track node in getting the address of group leader for the particular group. The task of group leader is equally distributed so that the new member is responded without delay. The graph displayed in figure 13 marks the flow of cure for three location aware protocols. The yellow line for SPBM goes upwards while an increase in the number of groups. The blue color for MSRDMP flows down the line for RSGM. The above discussed results ensures that the MSRDP offers better performance as scalability of groups and the number of group members per group is increased.

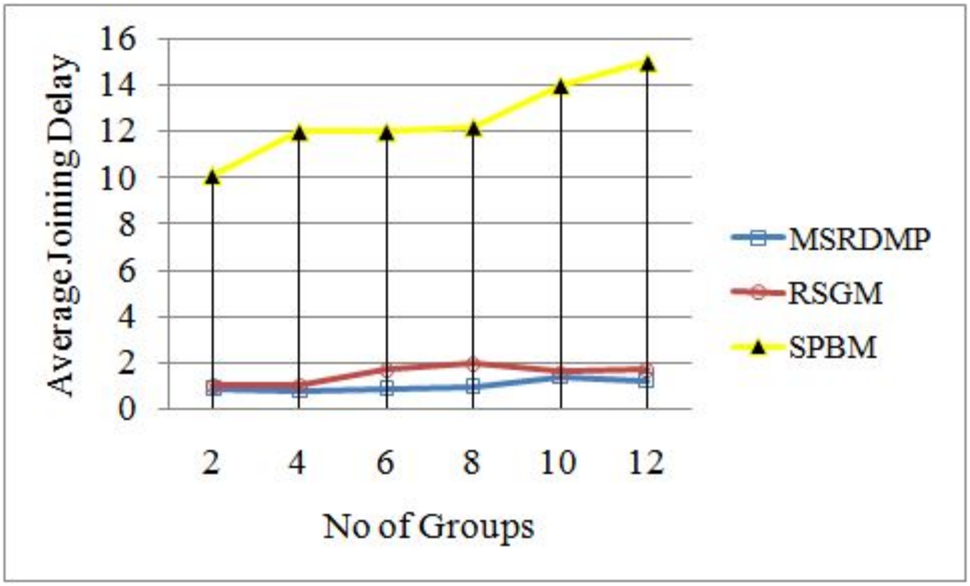


Figure 13. Average Joining Delay Vs Number of groups.

7. CONCLUSION

In multicast routing , the membership strength as well as the number of groups increases the management of the group is a very crucial task. To handle the scalability in group communication, a node which has not been deployed by authenticated user should not be permitted to join any group. The Enhanced MSRDMP provides the way that a node said to be intruder is isolated from the group using transit hello packet. The appendix packet is used to identify the new group formed by the authenticated user in a multicast environment. The enhanced MSRDMP is also a location aware protocol that offers very efficient performance when scalability is increased. The MSRDMP is compared with two existing protocols RSGM and SPBM. The comparison is made on group size and number of groups. The performance metric packet delivery ratio , control overhead, average path length and average joining delay are considering to prove that the enhanced MSRDMP provides the better scalability.

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AUTHOR BIOGRAPHY

R. Velumani received the B.E degree in Computer Science from K. S. Rangasamy College of Technology, Tiruchengode in 2001, M.E., in K. S. Rangasamy College of Technology, Tiruchengode in 2008, He worked as lecturer at M. P. Natchimuthu M. Jaganathan Engineering college from (2004-2006). He is currently working as Assistant Professor in Department of Computer Science and Engineering, K.S.R. College of Engineering and member of ISTE . His Current research interest includes Mobile Computing, Mobile Ad Hoc Networks.

Dr. K. Duraiswamy received the B.E., M.Sc. and Ph.D. degrees, from the University of Madras and Anna University in 1965, 1968 and 1987 respectively. He worked as a Lecturer in the Department of Electrical Engineering in Government College of Engineering, Salem from 1968, as an Assistant professor in Government College of Technology, Coimbatore from 1983 and as the Principal at K.S.Rangasamy College of Technology from 1995. He is currently working as a Dean Academic, Department of Computer Science and Engineering at K.S.Rangasamy College of Technology (Autonomous Institution). His research interest includes Mobile Computing, Soft Computing, Computer Architecture and Data Mining. He is a Senior Member of ISTE, IEEE, and CSI.