INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

Improve Multicast Forwarding for Mobile Ad-Hoc Network: A Survey

Akshay R. Patel
Computer Engineering Department
Sardar Vallabhbhai Patel Institute of technology, Vasad, Gujarat, India
Rashmin Prajapati
Assistant Professor, Computer Engineering Department
Sardar Vallabhbhai Patel Institute of technology, Vasad, Gujarat, India

Abstract:
Multicasting is increasingly important for mobile ad hoc networks (MANETs). A MANET is comprised of mobile nodes, potentially without any infrastructure. Many MANET applications need multicasting, as it provides a simple and reliable communication mechanism by using the inherent broadcasting property of wireless transmissions, and can significantly improve the bandwidth efficiency. Multicasting reduces transmission overhead and power consumption. In the past couple of years, several multicast routing protocols have been proposed for both wired networks and MANETs. In this thesis, a simple but Scalable Multicast Forwarding (SSMF) is developed. The proposed SSMF protocol is an extension of Simplified Multicast Forwarding (SMF) for MANETs, and is independent of any underlying unicast protocol.

***Key words**: AODV, MAODV, SSMF*

1. Introduction

Given the increasing demand for flexibility as well as technological advances in mobile communication devices such as wireless LANs, laptop computers and smart mobile phones, wireless communications are becoming more and more common. There are several advanced efforts to enable wireless communication over mobile networks. Multicasting is one such effort that strives to provide support for wireless communication in mobile networks.

1.1. Multicasting in Mobile Ad Hoc Networks (MANETs)

In the Internet, multicasting means transmission of packets to a group of zero or more hosts identified by a single destination address [1]. The idea of multicasting is intended in scenarios, where, all members in the host group need to receive the same packets from one or more sources. Membership in the multicast group can change dynamically.

A MANET comprises self-organized wireless mobile nodes that share a common wireless channel that can work without the support of fixed infrastructure or centralized administration. Two nodes can communicate either by single-hop transmission, if they are within each other's transmission ranges, or by multi hop transmissions through intermediate nodes that will serve as relays. Multi-hopping is usually required due to limited transmission power. Each node participates in the network as both host and a router.

1.1.1. Advantages

Multicasting reduces the communication costs for applications that send the same data to multiple recipients. Instead of sending data through multiple unicasts, multicasting minimizes the link bandwidth consumption and delivery delay [4]. Figure 1 shows a topology of one source and three destinations when using both multicast and unicast and depicts this advantage

1.1.2. Challenges

MANETs have several characteristics not present in wired networks: rapid deployment, robustness, flexibility, inherent mobility support, highly dynamic network topology (device mobility, changing properties of the wireless channel (e.g., fading and multipath propagation), and partitioning and merging of ad hoc networks are possible), limited battery power, limited capacity, and asymmetric/unidirectional links [5, 6].

The above characteristics of MANETs create challenges for multicasting [2, 3, 6-7]. The key problem of multicasting in MANETs is to enable efficient delivery of packets from a sender to multiple receivers, when the nodes are mobile. A highly dynamic topology is the biggest challenge for the robustness of a multicast protocol. In comparison, for wired networks, MANETs have a lower channel capacity, which is the result of noise and interference inherent with the wireless transmissions. As a result, there is always a tradeoff between reliability and control overhead. This tradeoff in turn affects the performance of the protocol.

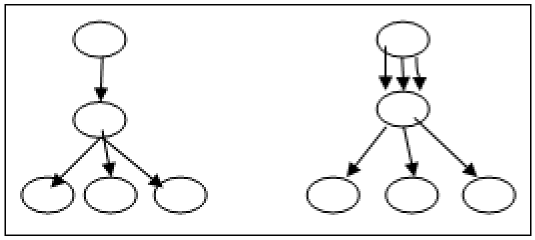

Figure 1: Network topology with one sender and three receivers when using (a) multicast, and (b) unicast

2. Taxonomy of Multicast Protocols in Manets

Recently, many multicast routing protocols have been proposed specifically for MANETs. These include multicast ad-hoc on-demand vector (MAODV) [17], core assisted mesh protocol (CAMP) [18], location guided tree (LGT) [19], on-demand multicast routing protocol (ODMRP)[20], forwarding group multicast protocol(FGMP)[21], ad-hoc multicast routing(AM Route) [22], multicast core extraction distributed ad-hoc routing (MCEDAR) [23] and differential destination multicast (DDM)[24]. Most of these multicast routing protocols are primarily based on distance-vector, stateless or link-state routing with additional functionality incorporated to assist the routing operations. The goals of all these protocols include minimizing control overhead, minimizing processing overhead, maximizing multi-hop routing capability, maintaining dynamic topology and preventing loops in the networks. However, many multicast routing protocols do not perform well in MANETs, because, in a highly dynamic environment, network topology changes frequently and unpredictably. Moreover, bandwidth and power are limited. This section presents the life cycle of a MANET multicast protocol, and their algorithms that are largely dependent on characteristics, closely related to the stages of the life cycle.

2.1. Multicast Session Life Cycle

A general multicast session undergoes different stages to complete the steps of a life cycle as shown in Figure 2. The most important stages and their sub stages involve [22]:

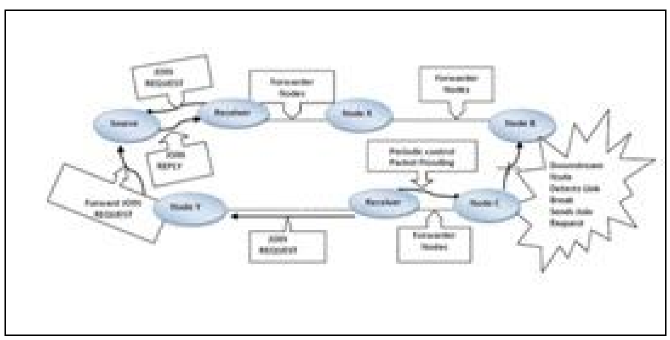

Figure 2

2.1.1. Initialization of Multicast Session

- Registration
- De-Registration

Both Registration and De-Registration can be receiver or source initiated.

2.1.2. Multicast Information Dissemination of Topology

- Flooding
- Tree-based (Source or Shared)
- Mesh-based

2.1.3. Multicast Topology Maintenance

- Reactive
- Proactive

In all the lifecycle stages joining, leaving, rejoining and session maintenance affect the performance of a multicast protocol. The routing scheme used is either reactive or a proactive. A source or a receiver can sends JOIN requests to initiate a multicast group.

These requests are propagated until the respective source or a receiver is found which in turn sends JOIN replies back. The path to the source(s) and/or receiver(s) is established from the JOIN replies and requests received, as they will hold all the addresses of intermediary nodes. These intermediary nodes mark themselves as forwarder nodes.

A session can be ended by explicit leave messages or by implicit periodic updates i.e. not replying to any JOIN requests. Subsequent sections present the classification of MANET algorithms based on above stages of multicast session life cycle.

3. Overview of MANET Multicast Protocols

Some MANET broadcasting schemes like MPR flooding [26], Simplified Multicast Forwarding (SMF) [28], MANET unicast protocols called Optimized Link State Routing (OLSR) [32], Ad Hoc On-Demand Distance Vector (AODV) [37] and Multicast Ad Hoc On-demand Distance vector (MAODV) [17] a MANET multicast protocol are briefly described in this section. All these protocols use some of the algorithms previously discussed.

3.1. Multi Point Relay (MPR)-based Flooding

The concept of MPRs was developed to reduce the number of duplicate transmissions of pure flooding, while forwarding a broadcast message. In MPR-flooding [26], only subsets of neighbor nodes retransmit messages, unlike the pure flooding, where all the neighbors forward the messages. A neighbor node, which forwards a message, is referred to as relay node of the peer. MPR nodes are chosen based on messages exchanged between one hop neighbors. The information required to calculate the multipoint relays is the set of one-hop neighbors and the two-hop neighbors, i.e. the neighbors of the one hop neighbors. Most protocols use some form of periodic keep alive messages or commonly known as HELLO messages to obtain information about one-hop neighbors. In a mobile environment, these HELLO messages are exchanged by each node to refresh current information of their one-hop neighbors. Every node by sending HELLO messages can send its own one-hop neighbor information, so that, the two-hop neighbor set can be computed. Thus, with these HELLO messages, each node can independently calculate its one-hop and two-hop neighbor set. The multipoint algorithm is designed such that every node will select relay nodes, such that, it can reach its entire two-hop neighbors. Figure 3 compares normal and MPR - flooding.

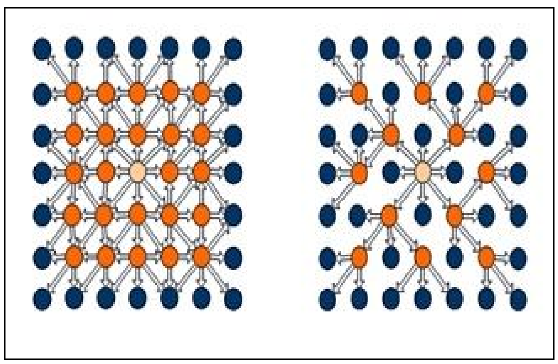

Figure 3: Normal (a) and MPR Flooding (b) [26]

The MPR algorithm is designed to provide a near optimal MPR set and is very simple to implement. The problem of selecting optimal MPR set is NP-complete. The two algorithms used in MPR-flooding are:

<u>3.1.1. MPR Selection for Node u</u>

- Select as MPR all the neighbors of node u that are the only neighbors of a 2-hop neighbor of node u;
- While an uncovered 2-hop neighbor from u still remains:
- Select as MPR a neighbor of u that is neighbor to the largest number of uncovered 2-hop nodes.

<u>3.1.2. MPR Flooding</u>

Each node u that receives a broadcast message will forward it only if the node u is an MPR of the previous hop of the message and has never received the message before.

Thus, even though the classical flooding (CF) scheme is more robust and reliable, it consumes a lot of bandwidth. Multi-point relaying gives equally good results with much lower overhead traffic.

3.2 Simplified Multicast Forwarding (SMF)

Flooding is the simplest form of broadcasting data in MANETs. However, due to broadcast storm problem in flooding, many mechanisms that minimize the packet forwarders were introduced. SMF also specifies mechanisms for applying reduced relay sets to achieve more efficient multicast data distribution within a mesh topology versus simple flooding. Flooding optimizations include Connection Dominating Set (CDS) (in graph theory, a dominating set (DS) for a graph is a set of vertices whose neighbors, along with themselves, constitute all the vertices in the graph, a connected DS (CDS) is a DS forming a connected graph), Multi Point Relay (MPR) [26] set etc. SMF is one such simple scheme that tries to minimize the problems in CF scheme. SMF basically is comprised of three parts:

- Sequence id generator and marker to be used when and if necessary,
- Duplicate detection module, and
- Basic multicast packet forwarding module.

All these three modules help in providing a working prototype compatible with existing and emerging IP network protocol frameworks. The sequence generator is responsible for marking each packet with a monotonically increasing unique identification number when existing IP kernel methods are not sufficient or are not predictable. The duplicate detection mechanism is used to remove and detect duplicate packets from both entering the interface forwarding process and from being delivered to upper layer applications. The multicast forwarding module is flexible in its design and presently supports different flooding design optimizations. The current experimental mechanisms are: CF, source-specific multi-point relay (S-MPR) flooding, and non-source multi-point relay (NS-MPR), Essential Connecting Dominating Set (E-CDS) and Multipoint Relay Connected Dominating Set (MPR-CDS).

The S-MPR flooding mechanism is based on the MPR technique described in Section 2.5.1. The current algorithm selects MPRs which are one-hop away, to build a reduced relay set to reach all of its two-hop neighbors. S-MPR allows only locally elected MPRs to retransmit packets that are received from upstream nodes. Symmetric two-hop neighbor knowledge can be collected via single HELLO exchanges. Source-specific MPRs compose a connected dominating set, and using S-MPR significantly reduces redundant retransmission of packets [31], especially in dense network neighborhoods. However, there is an implementation disadvantage of S-MPR as it requires previous hop identification to perform a proper forwarding match, thus, adds some additional state and complexity to the design.

A flooding technique that does not require previous hop information during the forwarding decision process and overcomes S-MPR drawbacks is called NS-MPR. The NS-MPR mechanism combines all source-specific elected MPRs into a common relay node set. In this case, only knowledge that a node is an MPR for at least one neighbor is used and previous hop information is not required during the active forwarding process. However, NS-MPR does not scale well as compared with the S-MPR approach. That is, there is no significant decrease in a combined resultant relay set when compared to a source-specific relay set. Research is still carried out to investigate optimization algorithms, to form common relay set not requiring previous hop knowledge.

The third flooding scheme called Essential Connected Dominating Set (E-CDS) is based on the E-CDS algorithm described in a proposal for MANET extensions to OSPF using CDS flooding [63]. The E-CDS algorithm forms a single CDS mesh for the entire network similar to NS-MPR and allows nodes to use 2-hop neighborhood topology information to dynamically perform relay self election to form a CDS. Nodes elect themselves as relays using neighborhood router priority information. Priority values need not be unique and can be a combination of values such as power level, number of one-hop neighbors and address values. For nodes to correctly assign themselves as relays, priority values need to be learned within a two-hop neighborhood. E-CDS nodes select themselves as relays if and only if:

- The node's router priority is greater than all its two hop neighbors, or
- There does not exist a path from the highest priority neighbor to all other one and two hop neighbors using only nodes with greater priorities as relays.

With E-CDS, any SMF node that has selected itself as a relay performs duplicate detection (DPD). E-CDS, unlike SMPR, does not guarantee minimal hop paths for end to end connections. Because E-CDS uses a shared CDS, there may be higher traffic concentration within the network forwarding paths compared to source based approaches.

The final algorithm presented is the MPR-based Connected Dominating Set (MPR-CDS) algorithm [64]. The number of forwarding nodes in MPR-CDS is reduced to a more efficient subset of MPRs than the simple NS-MPR described previously. MPR-CDS requires that nodes know a unique ordering identifier for each node within their two-hop neighborhood. After neighborhood discovery, a node using MPR-CDS will forward all unique packets if and only if:

- THE node's identifier is higher than all its one-hop neighbors, or
- NODE has been selected as an MPR by the node that has the highest identifier in its one hop neighborhood.

Like E-CDS, MPR-CDS approach results in a common relay set, and does not guarantee minimal hop paths. MPR-CDS also has no requirement for previous hop knowledge similar to other shared CDS algorithms. MPR-CDS has similar scaling properties to both E-CDS and S-MPR [65].

All the SMF forwarding schemes present robustness to changes in topology caused by network mobility and increasing traffic loads. However, there is still ongoing research on the interoperation of SMF with multicast MANET border routers and other existing exterior multicast protocols.

3.3. Optimized Link State Routing (OLSR)

OLSR is a link state algorithm modified for mobile networks. In OLSR, only MPRs forward link state information. Furthermore, only partial link state information is exchanged between MPRs. The link state information is used to calculate OLSR routing tables.

We will discuss three important stages involved in maintaining OLSR routing tables.

3.3.1. Link sensing

MPR link state information is exchanged between the mobile nodes through the exchange of HELLO packets. The HELLO packet message format is shown in the Figure 4 [32]. HELLO packets are periodically transmitted over the interfaces to detect connectivity with the neighbors. A link is assigned a status like, symmetric "or 'asymmetric' based on whether a pair of HELLO packets are heard or not heard from both the directions on the links respectively. This way a node maintains a link set, which contains the information of links to its one-hop neighbors.

3.3.2. Neighbor Detection and MPR Selection

Based on the link set on a node obtained from the exchange of HELLO packets, a neighbor set is created. A node is called a neighbor of another node if and only if there exists at least a link between them. Nodes also maintain a two-hop neighbor set, that is, a set of nodes which have symmetric link to symmetric neighbors. The MPR set is computed based on two-hop neighbor set. A node will select the MPRs such that any strict two-hop neighbor is covered by at least one MPR node.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1

+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
|        Reserved        |  Htime  |  Willingness           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
|  Link Code  |  Reserved  |  Link Message Size             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
|             Neighbor Interface Address                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
|              Neighbor Interface Address                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
:                                        :
:                                        :
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
|  Link Code  |  Reserved  |  link msg Size  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             Neighbor Interface Address             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
|             Neighbor Interface Address
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
```

Figure 4: OLSR Hello packet format [32]

The MPR list is recalculated every time there is a change in the link state information which results in a different one-hop and two-hop neighbor set.

3.3.3. Topology Control Message Diffusion

A node announces its link-set by flooding Topology Control (TC) messages. TC messages are flooded through MPR flooding. TC messages use an Advertised Neighbor Sequence Number to ensure the "freshness" of the announced link-set. TC messages are sent at regular intervals, and are also triggered by link-set changes and MPR selection set changes. The TC message format is shown in Figure 5 [32].

```
0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
|       ANSN       |         Reserved          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Advertised Neighbor Main Address                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
|            Advertised Neighbor Main Address       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|               ......                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
```

Figure 5: TC message format [32]

3.4. Ad hoc On-demand Distance Vector (AODV)

The information in this section was obtained from the Ad Hoc on Demand Distance Vector Protocol (AODV) RFC [37]. AODV is a reactive protocol, that is, the routes are created and maintained only when they are needed. Route Request (RREQ) is flooded by the source host to find the path to destination host. The RREQ message includes the destination sequence number, which not only prevent

loops, but prevents old information to be replied to the request. The source host finds the destination host's sequence number from its routing tables which stores information about the next hop to the destination and a sequence number.
On receiving RREQ messages, the intermediary nodes update their routing tables. The destination host or any intermediate node (if it has the path to the destination) can reply using Route Reply (RREP) message. Each host also has its own sequence number, which must be incremented in two different cases:

- Before source host sends RREQ message, and
- When the host sends a RREP message responding to the RREQ message

AODV uses a third type of message called Route Error (RERR). When a node detects any breaks in the active routes it sends RERR messages toward the source. Link breaks can be detected via periodic HELLO messages. The host originating RERR messages should increment the RERR message sequence number before broadcasting it locally, to prevent replies for old RERR messages.
AODV reduces the overhead of maintaining routes at the cost of increased latency in finding new routes. The AODV protocol will perform better in networks with static traffic and relatively small number of source and destination pairs, unlike OLSR which is more efficient at a high density and random traffic.

3.5. Multicast Ad-hoc On-demand Distance Vector (MAODV)

MAODV is a multicast extension of AODV. In MAODV, all members of a multicast group belong to a tree (which includes non-member nodes required for the connection of the tree), and the root of the tree is the group leader. Multicast data packets are propagated using the tree. The core of the MAODV protocol is on the tree formation, maintenance, repair the tree and tree merging. There are four types of packets in MAODV: RREQ, RREP, Multicast Activation (MACT) and (Group HELLO) GRPH. RREQ and RREP are also packets in AODV. A node broadcasts a RREQ when

- It is a member node and want to join the tree, or
- It is a non-member node and has a data packet targeted to the group.

When a node in the tree receives a RREQ, it responses with RREP using unicast. Since RREQ is broadcasted, there may be multiple RREPs received by the originating node. The originating node should select one RREP that has the shortest distance to the tree and unicast a MACT along the path to set up a new branch to the tree. GRPH is periodically broadcasted by group leader to allow the nodes in the tree to update their distance to the group leader. More detailed information on MAODV can be found in [17].

4. Proposed Work

- Scalable Simple Multicast Forwarding (SSMF)
  The need for different multicast forwarding schemes for different MANETs or topology scenarios has been presented in the previous chapters. The requirement for multicast algorithm's independency with respect to any unicast protocol was also discussed previously. There is a need for protocols which can integrate well with already existing multicast protocols in the wired network.

4.1. Problem Formulation

A single multicast protocol is not suitable for all types of networks and aims to meet maximum possible requirements for different network conditions. Section 2.4 described some features required by a multicast algorithm to function efficiently in MANETs. For the efficient function of multicast algorithms, there is a need to separate multicast data dissemination for different network scenarios. The two basic networks scenarios or conditions can be the following:

- Localized scenario: that has a very dense network of multicast receivers.
- Scattered Scenario: that has a few and a scattered network of multicast receivers.

A protocol able to adapt to different network conditions can make it highly efficient. Two different broadcasting schemes can be proposed for the above two network scenarios:

- For the first condition(the localized scenario), a proposal of a broadcasting mechanism is limited flooding. The scope of flooding can be limited by appropriately choosing a TTL of the packets to be flooded.
- For the second scenario (scattered network), flooding can be combined with any underlying unicast protocol to reach all the scattered hosts.

The limited flooding combined with any MANET unicast protocol will eliminate unnecessary dissemination of data as well as its dependency with respect to any specific unicast protocol. The combination not only allows flooding to reach dense part of a network, but also allows sources to reach scattered hosts very sparsely located, through unicast, ensuring reliability of packet delivery as well as saves lot of bandwidth with limited flooding.

4.2. Design

The proposed approach goals and definitions defining various stages of a multicast protocol life cycle are presented in this section.

<u>4.2.1. Goal</u>

IETF currently considers Simple Multicast Forwarding (SMF) scheme [28] for forwarding multicast packets in MANETs. SMF uses MPR-flooding as one of its options. The major advantage of this scheme is its simplicity and efficiency with respect to node movement. However, SMF also has some disadvantages like needless data duplication i.e., sources even with no receivers flood the entire network. SMF also does not properly integrate with existing wired protocols like PIM. There is still ongoing research on the integration of SMF with other exterior multicast protocols. Our goal is to modify SMF so that it can overcome aforesaid problems.

4.2.2. SSMF

In our proposed multicast protocol SSMF:

- All the multicast receivers in a group have to register to all potential multicast sources in the multicast group of interest. The registration packet(s) can be unicasted and/or MPR-flooded (limited flooding) to the sources;
- The sources store a list of all interested receivers in their multicast group in a receiver table. Each receiver entry is accompanied by its distance (in terms of hop count) from this particular source;
- For each list of receivers, a source will compute a combination of limited scope flooding (with a limited TTL) and unicast to reach all the multicast receivers.
- Hence, the scheme aims to minimize the flooding overhead compared to that of SMF, by choosing the best combination of limited flooding (with TTL) and unicasting.

4.2.3. SSMF Definition

The above proposed scheme is named as Scalable Multicast Forwarding (SSMF) and this section provides detailed SSMF protocol definition. When a receiver joins a multicast group (and periodically thereafter), the node simply broadcast JOIN requests to a multicast group; the multicast sources for a particular group, on receiving these requests, add them to their receiver tables. Since registration is initiated by the receivers, SSMF is a receiver-initiated approach.

For de-registration, two methods can be employed:

- An explicit deregistration message can be sent to the multicast source by its multicast group's receiver. Upon reception of this explicit message, the source simply removes that receiver from its receiver table.
- Since receivers periodically broadcast their group membership to their multicast group(s) source(s), these sources(s), store the active receiver(s) and their hop count. A timer can be employed on the sources receiver tables to periodically flush the inactive receivers upon timeout.

For the implementation of SSMF in this thesis both of the above methods are used.

In this paper, the timeout value is chosen as three periodic updates plus a small guard time of about (0.05s), that is, if a source does not get three consecutive periodic updates, then source will wait some extra guard time period, before eliminating the receiver from its tables.

The multicast sources store in the receiver tables the distance or number of hops to the respective receivers. The sources will update the hop counts for each receiver by one of these methods:

- If a proactive unicast routing protocol is being used, the hop count can be directly obtained from the unicast routing table, or
- From the periodic updates messages the receivers (the periodic SSMF JOIN messages will carry this hop count values); if multiple updates are received, the minimum value is used.

In this thesis for robustness, the maximum of hop count values obtained from the above two ways are used. Proceeding to SSMF‟s dissemination of multicast data, a source will have to choose between a combination of limited scope SMF flooding, and unicasting. The mechanism for choosing the correct combination of flooding and unicast is explained in section 3.3. In the broadcasting mechanism of SSMF, decision of flooding with TTL and unicast depends on knowing the current TTL values. To guard against an increase in the TTL values due to changes in the links, limited scope flooding should be carried out with an additional safety factor. Depending on the rate of link changes, the rate of updating the TTL values and an appropriate „safety‟ factor can be chosen. However, if the TTL is obtained from a responsive proactive unicast routing protocol, then, only a small safety is required as updating the TTL value is accomplished by the underlying unicast protocol. The safety value added to the optimum TTL value will represent a trade-off between registration and data overhead.

4.3. Protocol Specification

4.3.1. Adaptive TTL Flooding

This section presents the calculation of the optimum TTL for limited flooding in SSMF. Assume that N nodes are uniformly distributed in a rectangular lattice. Given a node i in the lattice, there are 4k nodes at a distance of k hops from i. A flood with a TTL=k will have $N_k$transmissions, where,

Nk =0.45(1+2k (k+1))

Since the flooding mechanism in SSMF is SMF, the total number of forwarding nodes will be less than N_k. The worst case for this scenario is pure flooding, where; every node in the relay set is an MPR. According to the literature [57-58], the number of total number of forwardingnodes by using MPR flooding will be approximately 45% of N_k.

Similarly, there is a need to calculate the number of forwarding nodes or overhead data packets for unicast messages in order to quantify the tradeoff between the SMF flooding and unicasting to a group of SSMF multicast receivers. For unicast delivery, the forwarding hops will be same as the value of hop count or TTL in the unicast tables of senders.

Based on the overhead for a certain TTL and unicast, the optimum TTL (the one that minimized the number of transmissions) can be computed.

For example, let there are a source and five receivers located at one, two and three hops away from the source shown in the Figure 6.

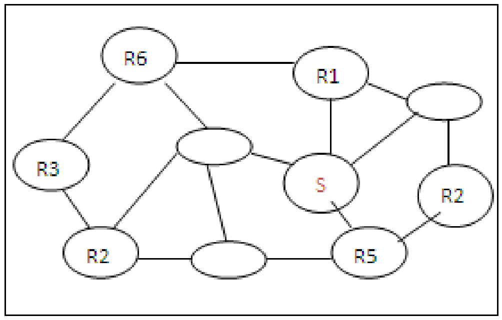

Figure 6: An example MANET with a source and multicast group consisting five receivers.

Table 1 shows the receiver table for the network topology shown in Figure 6. Table 2 shows how an optimum TTL can be chosen based on the information in the receiver table.

Receivers	Hop Count
R1	1
R2	2
R3	3
R4	2
R5	1
R6	2

Table 1: SSMF receiver table at the SSMF source for topology in Figure 6

TTL{k}	Data overhead due to SMF (Packets) {.45 * [1+2k (k+1)] }	Data overhead due to Unicast (*Packets*) *{Hop count from periodic update table}*	Overhead {Packets}
0	0.45	11	11.45
1	2.25	9	11.25
2	5.85	3	8.85
3	11.25	0	11.25

Table 2: Overhead calculations for optimum TTL

The flooding TTL =0 i.e., k = 0 represents a case, when no limited flooding occurs and only unicast to all the group members will take place. If TTL is set to 1 for limited scope flooding using SMF, since, receivers R1 and R5 are one hop away from source, SMF flooding will cover them. The other receivers that are more than a hop away need the data to be unicasted to them. Since R2, R4 and R6 are two hops away and R3 is three hops away, total unicast packets generated is the sum of their hop counts i.e. in this case it is 2+2+2+3 = 9 packets. A similar calculation can be performed for each TTL. In this example, the optimum TTL is equal to two, as the combination of unicast and SMF flooding generates less data overhead for this TTL value, and the remaining receivers which are not covered by limited SMF flooding are unicasted

5. Conclusion and Future Work

5.1. Conclusion

By theoretical analysis it has been proved that by combining unicast and multicast .The no. of packet forward can be reduce .It has been applied theoretical.

5.2. Future Work

It has been applied theoretically and it is also applied to experiment in Future.

6. References

1. D.P. Agrawal and Q.A. Zeng, Introduction to wireless and mobile systems, Brooks/Cole (2003).
2. Luo Junhai and Ye Danxia et al., Research on topology discovery for IPv6 networks, IEEE, SNPD (2007), pp. 804-809.
3. S. Toumpis, Wireless ad-hoc networks, in: Vienna Sarnoff Symposium, Telecommunications Research Center, April 2004. Available from: http://www.eng.ucy.ac.cy/toumpis/publications/sarnoff04.pdf.

4. S. Paul. “Multicasting on the Internet and its Applications”. Kluwer Academic Publishers, ISBN 0-792-38200-5, 1998.
5. IETF MANET Working Group, http://www.ietf.org.
6. C.-K. Toh, Ad Hoc Mobile Wireless Networks: Protocols and Systems, Prentice-Hall, Englewood Clis, NJ, USA, 2002.
7. C. Perkins, Ad-Hoc Networking, Addison-Wesley, Reading, Mass, USA, 2000.
8. Cormen, Thomas H.; Leiserson, Charles E.; Rivest, Ronald L.; Stein, Clifford (2001). "Section 24.3: Dijkstra's algorithm". Introduction to Algorithms (Second Ed.). MIT Press and McGraw-Hill. pp. 595–601.
9. T. Ballardie, P. Francis, and J. Crowcroft, Core Based Trees (CBT): An Architecture for Scalable Inter-Domain Multicast Routing, Proc. of ACM SIGCOMM "93, 1993, p. 85.
10. Gossain, H.; Cordeiro, C.D.M.; Agrawal, D.P., "Multicast: wired to wireless," Communications Magazine, IEEE, vol.40, no.6, pp.116-123, Jun 2002.
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, vol. 2009, Article ID 764047, 42 pages, 2009.
12. Yogen K. Dalal and Robert M. Metcalfe, “Reverse path forwarding of broadcast packets”. Commun. ACM 21, 12 (December 1978), pp. 1040-1048.
13. T. Maufer, C. Semeria, "Introduction to IP Multicast Routing". Draft-ietf-mboned-intro- multicast- 03.txt. July 1997. 64
14. Adams, A., Nicholas, J., and W. Siadak, "Protocol Independent Multicast - Dense Mode (PIM-DM): Protocol Specification (Revised)", RFC 3973, January 2005
15. Waitzman, D., Partridge, C., and S. Deering, "Distance Vector Multicast Routing Protocol",RFC 1075, November 1988.
16. Fenner, B., Handley, M., Holbrook, H., and I. Kouvelas, "Protocol Independent Multicast - Sparse Mode (PIM-SM): Protocol Specification (Revised)", RFC 4601, August 2006.
17. E.M. Royer and C.E. Perkins, Multicast operation of the ad-hoc on-demand distance-vector routing protocol, ACM MOBICOM (1999), pp. 207-218 August.
18. J.J. Garcia-Luna-Aceves and E.L. Madruga, The core-assisted mesh protocol, IEEE JSAC (1999), pp. 1380-1394 August.
19. K. Chen and K. Nahrstedt, Effective location-guided tree construction algorithms for small group multicast in MANET, Proceedings of the INFOCOM (2002), pp. 1180-1189.
20. M. Gerla, S.J. Lee, W. Su, On-Demand Multicast Routing Protocol (ODMRP) for Ad-hoc Networks, Internet draft, draft-ietf-manet-odmrp-02.txt, 2000
21. C.C. Chiang, M. Gerla, L. Zhang, Forwarding group multicast protocol (FGMP) for multi-hop, Mobile Wireless Networks, AJ. Cluster Comp, Special Issue on Mobile Computing, vol. 1 (2), 1998, pp. 187-196
22. E. Bommaiah et al., AMRoute: Ad-hoc Multicast Routing Protocol, Internet draft, August 1998.
23. P. Sinha, R. Sivakumar, V. Bharghavan, and MCEDAR: multicast core-extraction distributed ad-hoc routing, in: IEEE Wireless Communications and Networking Conference, September 1999, pp. 1313-1317.
24. L. Ji and M.S. Corson, Differential destination multicast-a MANET multicast routing protocol for small groups, Proc. INFOCOM (2001), pp. 1191-1201.
25. Xiaojing Xiang, Xin Wang, Yuanyuan Yang, "Stateless Multicasting in Mobile Ad Hoc Networks," IEEE Transactions on Computers, vol. 59, no. 8, pp. 1076-1090, Apr. 2010.
26. T. Clausen, P. Minet, and C. Perkins, “Multipoint Relay Flooding for Manets”, Internet-Draft, IETF MANET working group, February 2004. 65
27. B.Williams and T. Camp, "Comparison of broadcasting techniques for Mobile Ad Hoc Networks", Mobihoc’03.
28. J. Macker, SMF Design Team, IETF MANET Working Group. [e-document].Simplified Multicast Forwarding for MANET (draft-ietf-manet-smf-02), 2006[retrieved March 24, 2011]. From: http://tools.ietf.org/html/draft-ietf-manet-smf-02.
29. Bhattacharyya, S., "An Overview of Source-Specific Multicast (SSM)", RFC 3569, July 2003.
30. Handley, M., Kouvelas, I., Speakman, T., and L. Vicisano, "Bidirectional Protocol Independent Multicast (BIDIR-PIM)", RFC 5015, October 2007.
31. P. Jacquet, A. Laouiti, P. Minet, L. Viennot, “Performance of multipoint relaying in ad hoc mobile routing protocols,” Networking, May 2002.
32. T. Clausen and P. Jacquet. “OLSR RFC3626”, Oct 2003. http://ietf.org/rfc/rfc3626.txt
33. Perkins, C, Belding-Royer, E. Das, S. (July 2003). “Ad hoc On-Demand Distance Vector (AODV) Routing”. IETF. RFC 3561. http://tools.ietf.org/html/rfc3561. Retrieved 2011