



Performance Comparison of Unicast and Multicast Routing Protocol in MANETs using NS2

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Abstract: MANET is a self organized network and is composed of various independent nodes connected in an arbitrary fashion. Communication over a MANET network basically occurs through some different types of communication, such as unicast and multicast. Our work is generally been focusing on two of the protocols i.e. unicast and multicast routing protocols AODV and PUMA respectively. We will be comparing the performance of both AODV and PUMA by varying the number of nodes and thereby calculating the throughput and packet delivery ratio.

Keywords: AODV; MANET; Multicast; PUMA; Unicast.

I. Introduction

A mobile ad hoc network is composed of several independent nodes connected arbitrarily [1]. These intermediate nodes act as routers and communicate with other nodes within its range through radio waves. The nodes which are not in its neighbor communicate via multi-hop protocols [9][11]. In general, MANET supports different types of communication unicast, multicast and multipath. In Unicast communication, stream of packets are sent from single source to a single destination [3] [12], whereas in multicast communication data packets are sent from single source to a number of destinations [3] [7].

In this paper, we will be focusing on mesh based routing protocols. A Mesh based Routing Protocol is based on enabling multiple paths among sending and receiving nodes. With the presence of several alternative paths, the performance of multicast routing protocol becomes efficient [7]. This paper will be considering a unicast protocol namely AODV (Ad hoc on demand Distance Vector) Routing Algorithm and a multicast protocol PUMA (Protocol for Unified Multicasting through Announcements) [3].

Ad hoc on demand Distance Vector (AODV) Routing Protocol is a unicast routing protocol [4]. In order to deliver a packet using this algorithm, a path will be created only when its need arrives. This packet forwarding is based on the usage of two messages: Route Request (RREQ) and Route Reply (RREP) [2] [4] [5]. When source node is willing to send packet to its destination, it first starts route discovery process by generating a route request (RREQ) message [8]. If the destination node receives this packet then it records a reverse path to the respective sender. It then rebroadcasts this established route over the network. After knowing the reverse path towards sender, the destination node will send an RREP message back tracking the sending node. Thus, by using unicast approach AODV establishes path to the destined node [8] [9] [10] [13].

PUMA is a multicast protocol that is based on Multicast Announcements (MA) where any multicast sender can send its data packets to multicast receivers without involving the group. Any non member node is capable of sending packets to multicast receiver without joining the group [3] [6]. PUMA is based on using a single control message; an MA is exchanged among other network nodes within the group [10]. Each multicast announcement specifies a sequence number, core ID, a group ID, distance to core, a mesh member with sending node belonging to the mesh, notifies other nodes about joining or leaving the group and parent node from which the node received latest announcement packet with minimum core distance [7]. Core node acts as a special receiver and is selected by core election algorithm. On the basis of MA packet received from the neighboring nodes, a node's connectivity list is maintained [3] [7]. PUMA being a multicast routing algorithm is not dependent on any unicast approach and doesn't support any pre-assigned nodes for its function [3] [10] [12] [14].

This paper is based on the comparisons made among the routing protocols. The main focus of this paper is on unicast and multicast routing protocol approaches. The organization of this paper is as follows: In Section II, this paper will be highlighting the related work in this stream. Section III defines these routing protocols, Section IV gives a brief introduction to the simulation tool used, Section V defines Experimental work, the simulation parameters, and the representation of the simulation result and Section V concludes the entire work and thereby describes the Future Work.

II. Related Work

A wide variety of MANET based application are based upon unicast communication [1] [11]. This type of communication allows MANET to successfully transmit data from one source to one single destination [12]. With advancement in application running over MANET multicast communication came into existence. Multicast communication provides a high packet delivery ratio even with high mobility and high traffic load [7]. The Ad hoc on demand Distance Vector Routing protocol is primarily based on unicast communication. AODV is a famous on- demand routing protocol for ad hoc network, it basically consists of route discovery and route maintenance processes. It uses three kind of control messages, Route Request (RREQ), Route Reply (RREP) and Route Error (RERR) [9]. AODV is based on the principle of discovering routes when needed. AODV algorithm has some capabilities; low network utilization, low processing, memory overhead and efficiently working under high mobility condition. AODV can be used to establish routes among two different network nodes. The route request will be made as per demand, which accounts for continuous change in network structure, thereby updating routing table. The information regarding next hop to the destination and sequence number will be stored in the routing table. Whenever a link between two nodes is broken, the routing table gets updated [8] [9] [10] [13]. In a similar way another approach used in MANET is based on multicast communication, PUMA. Protocol for Unified Multicasting through Announcement allows any source to send multicast packet to a multicast group [10] [12] [14]. It is in contrast that mesh based protocol, which has several paths between source and destination pair. Existing studies show that tree based protocols are not best suited for multicasting in MANET. Due to availability of multiple paths a mesh based protocol performs efficiently as compared to tree based protocol [3] [12]. This helps datagram packets to be sent to the destination even if the link fails [3]. An experimental approach is been followed in order to define the variation in performance of both unicast (AODV) and multicast (PUMA) protocols by determining the throughput and packet delivery ratio upon varying the number of nodes.

III. Routing Protocol

A. AODV

Ad hoc on demand Distance Vector routing algorithm is a unicast routing protocol and sends data packet to a single host. This protocol first aims at establishing a route where server sends a Route Request (RREQ) message. Destination node on receiving the packet will then generate a reverse path to the sender and will forward a Route Reply (RREP) message. After establishing this path the destination traces back to send RREP message to the sender [10] [11].

AODV is a dynamic distance vector routing protocol. In reactive routing the path establishes as per request by the node. In AODV the route discovery process involves two messages, i.e. RREQ (Route Request) and RREP (Route Reply). Destination sequence number is an important attribute for both RREQ and RREP. This attribute keeps on incrementing and determines freshness of this path [9] [13].

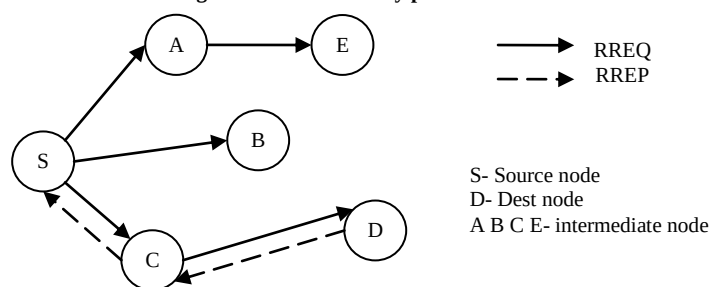
a) Route Discovery Process

The sending node S broadcasts message, RREQ to the neighboring nodes A, B and C and finds the optimal path to destined node D. After receiving RREQ message, the receiving nodes will [9]:

- 1) Sends RREP response, if the received node is the destination node and also determines “fresh enough route” in the path it establishes.
- 2) Updates routing table with reverse path from sender to destination. Rebroadcasting RREQ message until destined node achieves the “fresh enough route” value.

If for a given intermediate node, the destination sequence number of the RREQ message is less than or equal to the destination sequence number present in the routing table, then that node will have “fresh enough route”.

Figure 1 Route discovery process AODV



In the above figure, when destination D receives a RREQ message from node C, then it will reply with RREP message to node S and then forwards the reply to the node C. Node C will also send message to node S. Once S node receives RREP, it will call AODV by *recvReply()* function. This function updates entry for D, if either of the condition suffices [9] [10] [13].

- 1) The destination sequence number in routing table is greater than the destination sequence number of RREP message.

- 2) The destination sequence number in routing table and that of RREQ message is equal but one less than that of routing table.

If sending node S receives many RREP messages, the highest destination sequence number will be selected among these several RREP's.

B. PUMA

Protocol for Unified Multicasting through Announcements is a multicast routing algorithm that is generally working for a mesh based network. PUMA is based on multicast announcements (MA) and forwards packet from multicast sender to its destination within a multicast group [3] [14]. A Multicast Announcement is composed of Group ID, Core ID, Distance to Core, parent node sending latest announcement and notifies other nodes while an announcement is been sent. PUMA elects one of the nodes as core node and thereby informs other nodes of the elected core. PUMA being a mesh based multicast protocol is capable of collecting many receivers together and is liable to have many paths to reach the destination node. The multicast announcements in PUMA are capable of performing [3] [10] [12] [14]:

- 1) Dynamic election of core node:

PUMA elects one of the receiving nodes of the group as core of the group, and informs every router about the relative next hop to the elected core in each group. Each router will have one or more paths to reach the core node. Receiver searches for shortest path between itself and core and then connects the core node. A mesh member is flooded with data packets, and each packet is numbered such that as soon as a duplicate packet is encountered in will get dropped [3] [11].

- 2) Multicast Announcement Propagation:

A node that is elected as core keeps on sending multicast signals to the corresponding receivers. A connectivity list will be generated at each node as the multicast announcement reaches the receiving node. A connectivity list consists of details about parent node and distance to core. A node stores data from various MA that arrives from neighboring nodes. A new MA overwrites values that have lesser sequence number within that group [3]. Only latest information about sequence number will be kept for a given group A connectivity list stores the time of receiving the multicast announcement from the node, ID of the neighbor from which it was received and the multicast announcement. Best multicast announcement has to be selected.

- 3) Mesh Creation and Maintenance

In this step, only the receiving nodes are considered as member of the mesh, if the node is the receiving node it sets the flag as TRUE. Non receiving nodes are depicted as mesh members if they have at least one child. A node is predicted to be child node if

- (i) It is the member of the mesh and sets the mesh member flag to be TRUE.
- (ii) The nodes distance to core is lesser than distance of the neighbor to core.

A node will be a mesh member if it has a child node and depicts that it lies on the shortest path from core to receiver.

IV. Simulation Tool

Ns2 developed at the University of California, is an event driven network simulator program. It is an open source simulator used in the research field of networks by the research community. It supports both wired and wireless networks, is able to simulate various protocols such as UDP, TCP, unicast and multicast routing, etc. It is composed of several network objects protocols, applications and source traffic.

V. Experimental Work

In order to perform the simulation, we have taken the following parameters as defined in the given Table 1. By keeping one parameter as constant and varying the other two parameters, results are taken. These simulations play a very important role in further evaluation of results.

Table 1. Simulation Parameters

S.No,	Simulation Parameters and their values	
	Parameter	Values
1.	No. of nodes	10, 20, 30, 40, 50, 60
2.	Simulation Area	1000*1000 m
3.	Simulation Time	100 sec
4.	Speed	2 m/sec
5.	Mobility Model	Random Way Point
6.	Traffic Connection	CBR over UDP
7.	MAC	802.11
8.	Transmission Range	250m

9.	Packet Size	512 bytes
10.	Queue length	50
11.	Protocol	AODV, PUMA

Throughput

The term throughput defined as the number of the data packet transmitted from source node to destination in specified amount of time.

Figure 2 shows the variation of throughput when the number of nodes in the network is varied from 10 with the increase in their number by 10 each time and with a constant node mobility of 2m/s and simulation area 1000*1000.

Figure 2 Throughput (kbps) versus Number of nodes

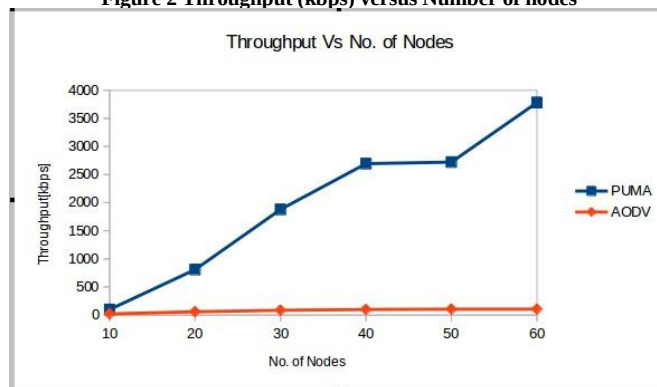
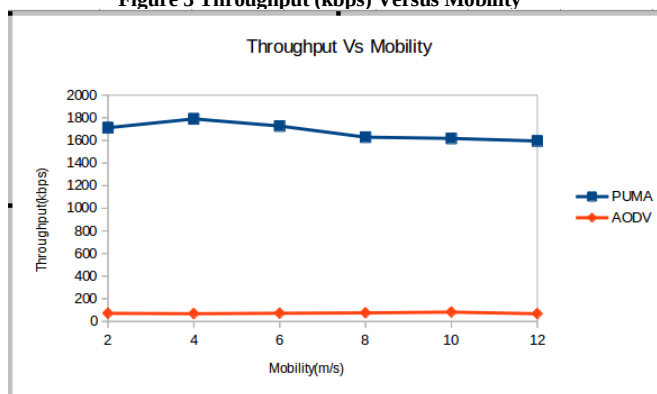


Figure 3 shows the variation of throughput when the mobility of the node is varied from 2m/s to 12 m/s, with a constant parametric value of simulation area as 1000*1000 m² and 30 number of nodes.

Figure 3 Throughput (kbps) Versus Mobility

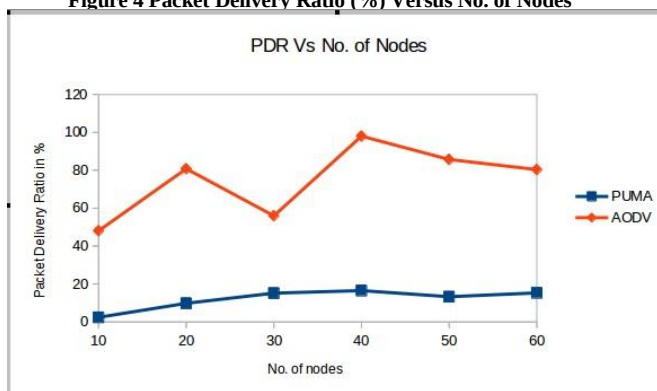


Packet Delivery Ratio (PDR)

PDR is the ratio of the number of data packet successfully delivered to the destination node and the number of data packets produced by source node.

Figure 4 shows the variation of packet delivery ratio when the number of nodes in the network is varied from 10 with the increase in their number by 10 each time and with a constant node mobility of 2m/s and simulation area 1000*1000.

Figure 4 Packet Delivery Ratio (%) Versus No. of Nodes



VI. Conclusion and Future Work

The Protocol for the Unified Multicast through Announcements (PUMA) is based on the novel idea of using simple multicast announcements to elect a core for the group, inform all route of their distance and next hop to the core, join and leave the multicast group. In addition it provides high throughput compared to the unicast routing protocol (AODV). We also intend to compare characteristics of PUMA with other multicast protocols in the near future.

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