Global Journal of Computer Science and Technology: E
Network, Web & Security
Volume 17 Issue 3 Version 1.0 Year 2017
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Comparative Analysis of Multicasting Routing Protocols in Mobile Adhoc Networks

By Gurjeet Singh & Prof(Dr.)Vijay Dhir
SBBS University

Abstract- Mobile Ad-Hoc Networks (MANETs) are autonomous and decentralized wireless systems. Mobile Ad hoc Network is a collection of mobile nodes in which the wireless links are frequently broken down due to mobility and dynamic infrastructure. Routing is a significant issue and challenge in ad hoc networks. Many Routing protocols have been proposed so far to improve the routing performance and reliability. This research paper describes comparative analysis of multicasting routing protocols in manet based on the different performance metrics like End to End delay, Throughput, Packet Loss.

Keywords: routing, protocols, DVMRP, MOSPF, PIM-SM, PIM-DM, CBT, MAODV, AMRoute, AMRIS, CAMP, ODMRP, PUMA.

GJCST-E Classification: *B.7.2, C.1.3*

COMPARATIVEANALYSISOFMULTICASTINGROUTINGPROTOCOLSINMOBILEADHOCNETWORKS

Strictly as per the compliance and regulations of:

Comparative Analysis of Multicasting Routing Protocols in Mobile Adhoc Networks

Gurjeet Singh [α] & Prof(Dr.)Vijay Dhir [σ]

Abstract- Mobile Ad-Hoc Networks (MANETs) are autonomous and decentralized wireless systems. Mobile Ad hoc Network is a collection of mobile nodes in which the wireless links are frequently broken down due to mobility and dynamic infrastructure. Routing is a significant issue and challenge in ad hoc networks. Many Routing protocols have been proposed so far to improve the routing performance and reliability. This research paper describes comparative analysis of multicasting routing protocols in manet based on the different performance metrics like End to End delay, Throughput, Packet Loss.

Keywords: routing, protocols, DVMRP, MOSPF, PIM-SM, PIM-DM, CBT, MAODV, AMRoute, AMRIS, CAMP, ODMRP, PUMA.

I. Introduction

It is the ability of a communication network to accept a single message from an application and to deliver copies of the message to multiple recipients at different locations. The goal of multicast is to provide efficient data delivery to a large set of receivers. In multicasting, senders send each data packet once and at most one copy of the packets flows through the physical links under normal conditions.

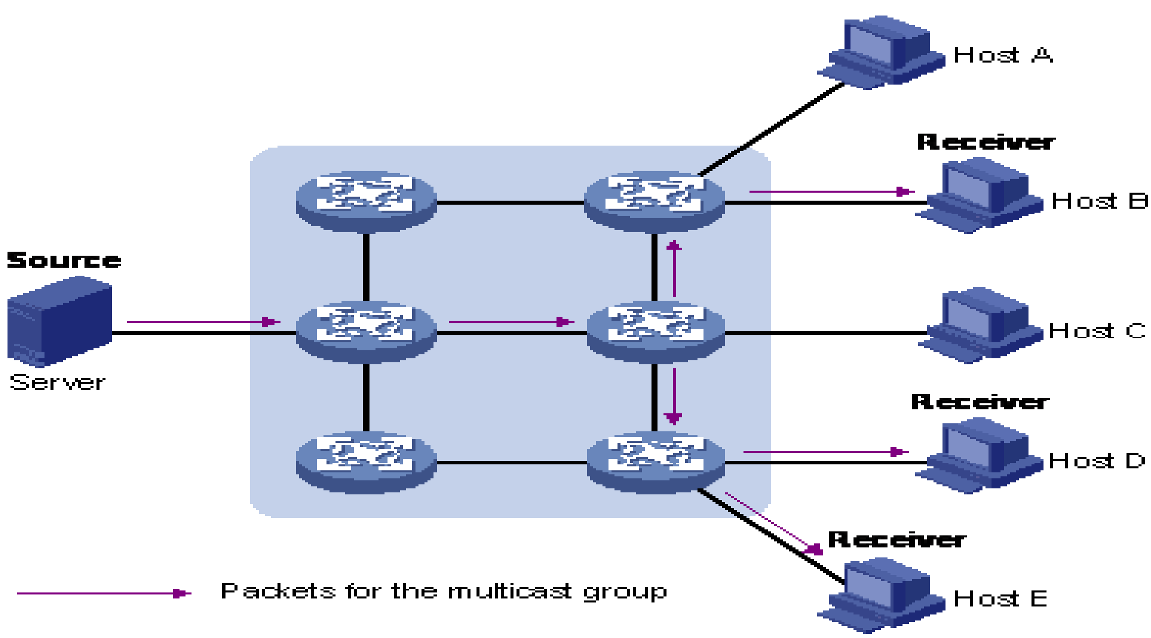


Figure 1.1: Multicasting Routing

According to diagram a Source wants to send a message to Receivers (to Host B, D and E). In case of unicast transmission, Source have to transmit the same data thrice and the bandwidth usage between the sender and the intermediate node will be thrice. In broadcasting, other Hosts (Host A and C) will get the packets although it is not relevant with the message sent, causing unnecessary bandwidth consumption. But in multicasting, only a single copy of the message is transmitted from the sender and it is copied at the intermediate node to be sent to the multicast group. A multicast group can range in size from a few nodes to several thousands.

There may be routers that do not support multicast on the network. A multicast router encapsulates multicast packets in unicast IP packets in the tunnel mode, and then sends them to the neighboring multicast routers through the routers that do not support multicast. The neighboring multicast routers remove the header of the unicast IP packets, and then

Author α: Ph.D, Research Scholar, SBBS University Jalandhar. e-mail: hi_gtech@rediffmail.com
Author σ: Dean Research, SBBS University, Jalandhar.

continue to multicast the packets, thus avoiding changing the network structure greatly (Mohammad Banikazemi, 2000).

II. Literature Review

The development of a practical implementation of IP Multicasting can be traced to one Stanford University graduate student, Steven Deering, who, in the late 1980's, was working on a network-distributed operating system called "Vsystem". His challenge was to provide some protocol mechanism that would allow multicast data to flow between IP sub networks. This goal, of course, required that the data-streams be able to move through IP routers . In addition, since Steve was working with Ethernet as his LAN media, he needed to address the issue of MAC multicast addressing. The work eventually led to his doctorate paper on the subject (Deering, 1991) and, subsequently, the premier IP-Multicasting IETF document - RFC 1112.

Robert (Robert et al., 2003) discusses the factors that determine the realism of a multicast tree and to quantify multicast bandwidth gain over unicast. They developed a characterization schemes to accurately model multicast tree for a wide range of group dynamics. The work involved collecting multicast data traces from MBONE and used that data to construct a characterization model independent of network distribution. Furthermore the metrics was then used to calculate a cost model. The paper emphasize that the shape and other characteristics of the multicast tree life like depth, degree average degree frequency and the receiver distribution directly influence the efficiency of the multicast tree. Unlike some previous works which consider all the nodes of the multicast tree as receivers, they differentiate between the actual receivers and transit nodes differently in their model. The tree properties identified in this work are very useful to model real multicast tree.

Kamil (Kamil et al., 2004) developed Trace tree a mechanism to discover the multicast tree topology. The scheme uses multicast forwarding states in the router to construct a multicast forwarding tree. The scheme employs a query response mechanism in which an interested querier send a query to all multicast enable router in the network for the presence of multicast states. Each multicast node then constructs a response message and sends it back. Also each router forwards the query to downstream multicast routers. The drawback of this technique is that it needs to add extra functionality to each router in the network. Also issues arise when multicast protocol in use constructs a bidirectional tree because this could lead to duplicate response packet and a flawed multicast tree image.

Mikael (Mikael et al., 2004) studied the impact of multicast state distribution upon the IPv6 network topology. They collected a map of the IPv6 network. The multicast tree was re-partitioned using their proposed function. The author claims that by building multicast trees using this function, the number of multicast states of the top ten most loaded nodes can be reduced up to 83% at the cost of a 5% increase of the total number of multicast states in the IPv6 topology.

III. Infrastructure Based Multicasting Routing Protocols

Multicasting is the ability to transmit multiple messages to a group of receivers simultaneously using a single broadcast channel. The idea is used extensively in various internet applications, such as:

This type of data transmission can be done in several ways that differ greatly in their performance. Choosing between the possible paths is not a trivial task, depending largely on network capabilities and the desired results.

To deliver the IP multicast packets to their destinations, at least one routing protocol must be implemented in the network.

These routing protocols include:

a) Distance Vector Multicast Routing Protocol (DVMRP)
b) Multicast Extension to Open Shortest Path First (MOSPF)
c) Protocol Independent Multicast Sparse-Mode (PIM-SM)
d) Protocol Independent Multicast Dense-Mode (PIM-DM)
e) Core-Based Tree (CBT)

IV. Infrastructure-Less Multicast Routing Protocols

A mobile ad hoc network lacks a fixed infrastructure and has a dynamically changing topology. The nodes move freely and independently of one another. Ad hoc networks are heavily used in emergency situations where no infrastructure is available, for eg. battlefields, disaster mitigation etc.

(Corson et al., 1999) Design of multicast routing protocol is difficult due to the inherent uncertainty and unpredictable dynamism. Several multicast protocols have been proposed for mobile ad hoc networks. Based on the network structure along which multicast packets are delivered to multiple receivers, multicast protocols can be broadly categorized into two types, namely tree-based multicast and mesh based multicast. The tree structure is known for its efficiency in utilizing the network resource optimally, while tree based protocols are generally more efficient in terms of data transmission. Mesh based protocols are more robust against topology changes due to availability of many redundant paths between mobile nodes and result in high packet delivery ratio. On the other hand, multicast mesh does not perform well in terms of energy efficiency because mesh-based protocols depend on broadcast flooding within the mesh and therefore, involving many more forwarding nodes than multicast trees.

In summary, the broadcast forwarding in mesh based protocols produces redundant links, which improves the packet delivery ratio but spends more energy than the tree-based multicast. The tree approach has some other drawbacks. The paths are non-optimal and traffic is concentrated on the tree, rather than being evenly distributed across the network. They are not robust to mobility as there is no back up path between a source and a destination, besides that, all tree based protocols need a group leader (or a core or a rendezvous point) to maintain group information and to create multicast trees.

A multicast packet is delivered to all the receivers belong to a group along a network structure such as tree or mesh, which is constructed once a multicast group is formed. However, due to node mobility the network structure is fragile and thus, the multicast packet may not be delivered to some members. To compensate this problem and to improve the packet delivery ratio, multicast protocols for ad hoc networks usually employ control packets to periodically refresh the network structure.

Following are the protocols to cope with multicast in ad-hoc networks.

1. Multicast Ad hoc On-demand Distance vector protocol (MAODV)
2. d-hoc Multicast Routing (AMRoute)
3. Ad hoc Multicast Routing protocol (AMRIS)
4. Core Assisted Mesh Protocol (CAMP)
5. On Demand multicast routing protocol (ODMRP)
6. Protocol for Unified multicasting through Announcements (PUMA)

V. Simulation Enviornment

In this PAPER we have one source node which is generating UDP connection. Simulation experiments were performed to determine whether some multicast routing protocols are more appropriate in certain traffic conditions and subscription level circumstances. The experiments were performed in ns-2, a discrete event simulation environment that is freely available.

Simulation of Fixed Network Protocols: Nodes and Links are demanded in wired network simulation for creating the topologies. Agent and traffic frame are attached to the nodes. And all the nodes are connected by link, the agent too.

Nodes: There are two important roles of a node in NS2. As a router, it forwards packets to the connecting link based on a routing table.

Links: There are three link types in NS2 which are Simplex-Link, Duplex-Link and Duplex-Intserv-Link.

Agents: An agent is a program that gathers information or performs some other service without our immediate presence and on some regular schedule. UDP a basic UDP agent is used in simulations.

Traffic Generators: Application can be classified into traffic generators (Traffic/CBR, Traffic/Exponential, Traffic/Pareto).

Traffic distribution to use for multicast

Constant bit rate (CBR): In this process, the packets are generated at the stations at a constant rate. This is one of the most simplistic models possible and exactly models CBR services.

A CBR traffic generator creates a fixed size payload burst for every fixed interval.

Table 1.1: CBR Traffic

Variable	Default value	Default value
Packet Size	210	Application payload size in bytes
Random	0 (false)	If true, introduce a random time to the inter-burst transmission interval.

Table 1.2: Simulation Parameters for Fixed Area Protocols

The simulation parameters	Parameter Value
Link bandwidth	100Mb/s
Link delay	10 ms
Session bandwidth	200kb/s
Join interval	1 (first receiver at0.03sec)
Number of receivers	4,8,16,32
Simulation time	8 s

Table 1.3: Simulation parameters for Mobile Adhoc Network Protocols

Parameter	Value
Area	1500*300
Number of Nodes	4,8,16,32
Simulation Time	8 sec
Transmission Range	250meters
Sending rate	2 packets per second
Node speed	0 -20m/s
Packet size	256 bytes
Bandwidth	100Mbps

Similarly, the simulations were performed by varying the size of group from 4 to 32 PUMA and MAODV are both receiver-oriented protocols. However, PUMA is a mesh-based protocol and provides multiple routes from senders to receivers. MAODV, on the other hand, is a tree based protocol and provides only a single route between senders and receivers.

VI. Results

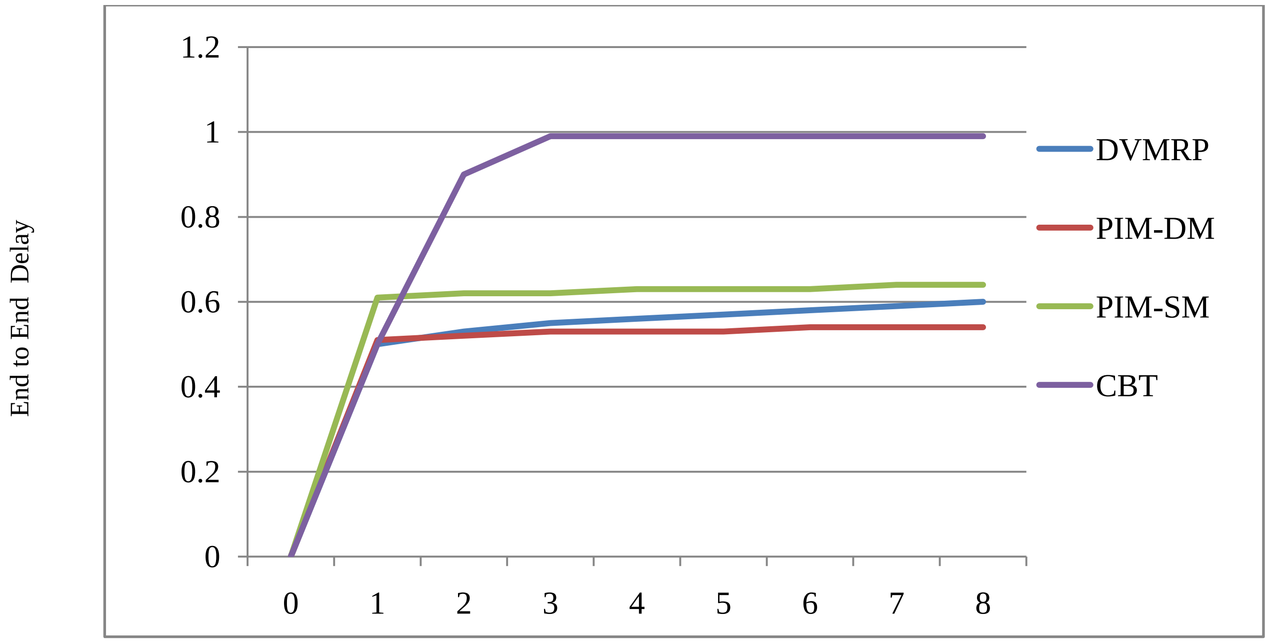
In this paper, we present the simulation results with different multicast routing protocols that we have described in the previous section. The simulation is done with discrete event simulation namely ns 2 version 2.35. Models in ns are created by defining nodes and connecting them with links to form some network topology.

As well as Infrastructure based protocols we also have evaluated the performance of PUMA and compared it with MAODV in terms of routing overhead, throughput, packet delivery fraction and end-to-end delay in NS-2.35. The obtained results are illustrated below. Multicast routing protocols are compared on the basis of different Performance Metrics. These performance Metrics are:

a) *End to End Delay*

Time elapsed between the generation of a packet at a source and the reception of that packet by a group member. Delay is the amount of time that it takes for a packet to be transmitted from one point in network to another point in a network. It refers to the time taken for a packet to be transmitted across a network from source to destination.

End-To-End delay was monitor at each multicast listener. The delay for CBT was relatively more than the rest of the protocols. CBT protocol also created a shared tree but the delay was much higher. The reason is the processing time at the RP. The delay has a fairly constant value for all the four protocols. second highest delay is produced by PIM-SM. All the three Remaining Protocols shows almost constant delay after one second which is not the case in CBT. They delay is highest in last time interval as the distance is also highest to move from source to destination(farthest receiver).



Simulation Time (in Sec)

Figure 1.2: End To End Delay (Infra. Based)

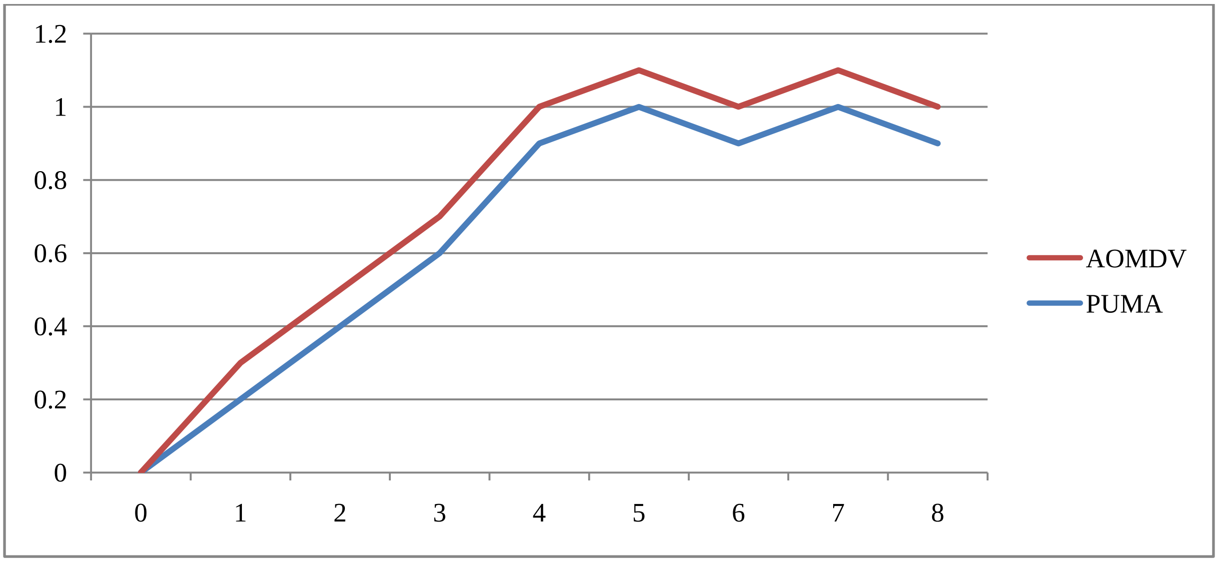
End to End delay for different Protocols according to varying topology is shown in table above. For real time application or critical applications end to end delay should be less. Lesser the end to end delay, better will be the performance.

End to End delay for all Multicast routing protocols is shown in the graph corresponding to the simulation time. End to End delay bears large variation in the graph, somewhere it is more and somewhere it is less. PIM-DM is better than DVMRP when comapred according to end to end delay metric. And among DVMRP,PIM-SM,PIM-DM and CBT , PIM-DM provides less end to end delay.

Table 1.4: End To End Delay (Infra. Based)

No.of Group Members	Four	Eight	Sixteen	Thirty Two
DVMRP	$10426964 \times (10)^{-9}$	$10426984 \times (10)^{-9}$	$10426949 \times (10)^{-9}$	$10426958 \times (10)^{-9}$
PIM-SM	$10426571 \times (10)^{-9}$	$10426727 \times (10)^{-9}$	$10426853 \times (10)^{-9}$	$10426789 \times (10)^{-9}$
PIM-DM	$10426856 \times (10)^{-9}$	$10426967 \times (10)^{-9}$	$10426769 \times (10)^{-9}$	$10426770 \times (10)^{-9}$
CBT	$11227 \times (10)^{-6}$	$11227 \times (10)^{-6}$	$11227 \times (10)^{-6}$	$11227 \times (10)^{-6}$

In ad-hoc networks End to End to End delay is as following.



Simulation Time (in Sec)

Figure 1.3: End To End Delay (Infra. Less)

Among AOMDV and PUMA ,AOMDV has higher End to End delay.PUMA has less End to End Delay. PUMA and MAODV are both receiver-oriented protocols. However, PUMA is a mesh-based protocol and provides multiple routes from senders to receivers. MAODV, on the other hand, is a tree based protocol and provides only a single route between senders and receivers.

Table 1.5: End To End Delay (Infra. Less)

No. of Group Members	Four	Eight	Sixteen	Thirty Two
MAODV	9735580 x $(10)^{-9}$	9795479 x $(10)^{-9}$	1x$(10)^{-6}$	2134430 x$(10)^{-6}$
PUMA	1 x $(10)^{-16}$	1 x $(10)^{-16}$	1 x $(10)^{-16}$	1 x $(10)^{-16}$

Based on the results shown above higher End-to-end delay values imply that routing protocol is not fully efficient and causes congestion in the network. As against the MAODV,
PUMA exhibits lesser values of End-to-end delay.

End-2-End delay = time (in seconds) when packet was received by OTHER NODE - time (in seconds) when packet was sent by CURRENT NODE (for calculations)

b) Throughput

Throughput is a generic term used to describe the capacity of the system to transfer data. Throughput is nothing but the bandwidth of the transmission channel. Throughput is the rate at which network sends or receives data. Throughput is much harder to define and measure because there are numerous ways through which throughput can be calculated:

- The packet or byte rate across the network.
- The packet or byte rate of a specific application flow.
- The packet or byte rate of host to host aggregated flows, or
- The packet or byte rate of network to network aggregated flows.

We have calculated throughput using following formula:

Throughput = Packets received / Packets forwarded

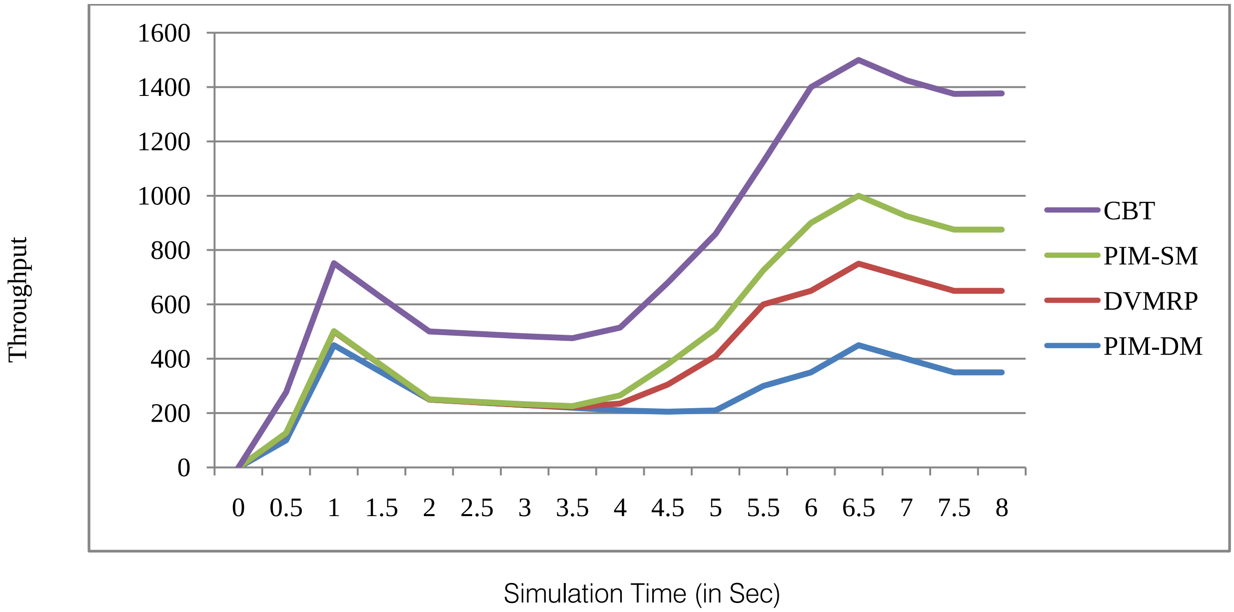


Figure 1.4: Throughput (Infra. Based)

Table 1.6: Forwarded Packets (Infra. Based)

No. of Group Members	Four	Eight	Sixteen	Thirty Two
DVMRP	2626	12249	33003	61333
PIM-SM	2608	12129	58822	32587
PIM-DM	2873	12231	35297	65251
CBT	4425	13902	39744	60739

Throughput of CBT is higher than all protocols while PIM-DM does not achieved the expected throughput ,same is the case for DVMRP but it performs good as compared to PIM-DM. Both

Sparse mode protocols performs very well as compared to both compared to dense mode protocols .The basic reason behind this is initial flooding by DVMRP and PIM-DM. Thats why the packets meant for actual receivers are too less as compared to sent packets

In ad-hoc networks PUMA outperforms as compared to MAODV because it relies on very good technique of announcements. The chances of failure are less, because it can choose its leader dynamically without the interference of Network designer.So there is no single point failure like problems.

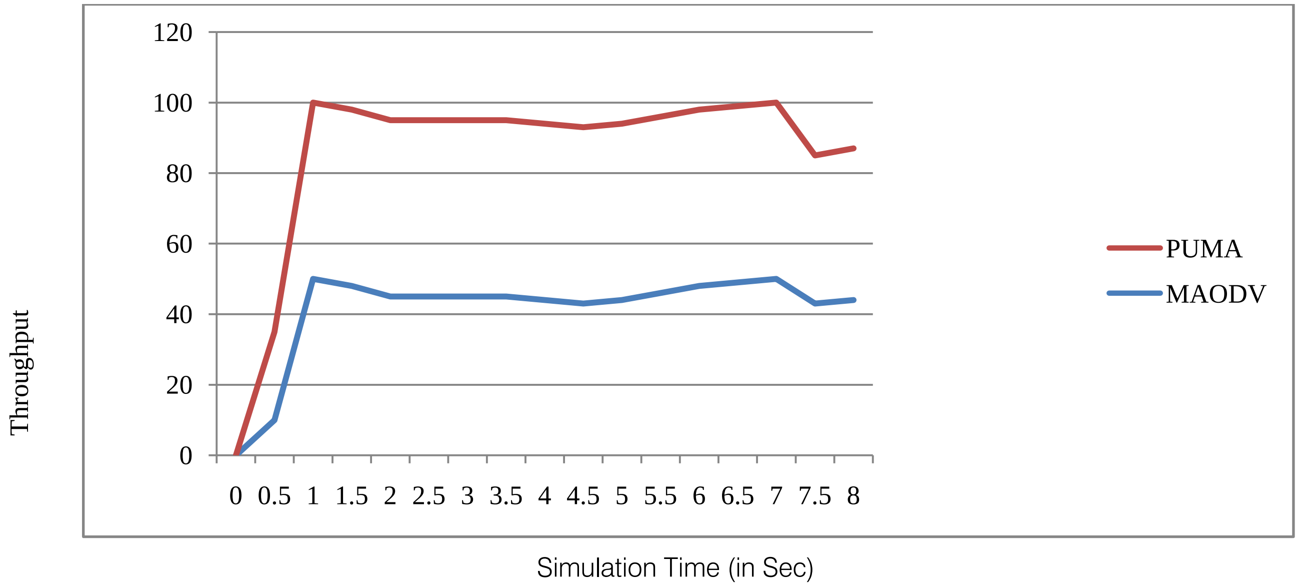


Figure 1.5: Throughput (Infra. Less)

Figure 1.5 shows the Throughput analysis. For increasing number of nodes the throughput of PUMA is higher than the MAODV.

Table 1.7: Throughput (Infra. Less)

No. of Group Members	Four	Eight	Sixteen	Thirty Two
MAODV	32	39	46	50
PUMA	93	97	100	100

Based on the simulation results shown above, the packet delivery fraction of PUMA is higher than MAODV for varying number of nodes.

c) Packet Loss

Packet loss is where network traffic fails to reach its destination in a timely manner.

Packet Lost = amount of packets received - amount of packets forwarded

There are three causes of packet loss in the network

- A break in Physical link that prevents the transmission of a packet
- A packet that is corrupted by a noise and is detected by a checksum failure at downstream node and Network congestion that leads to buffer overflow.

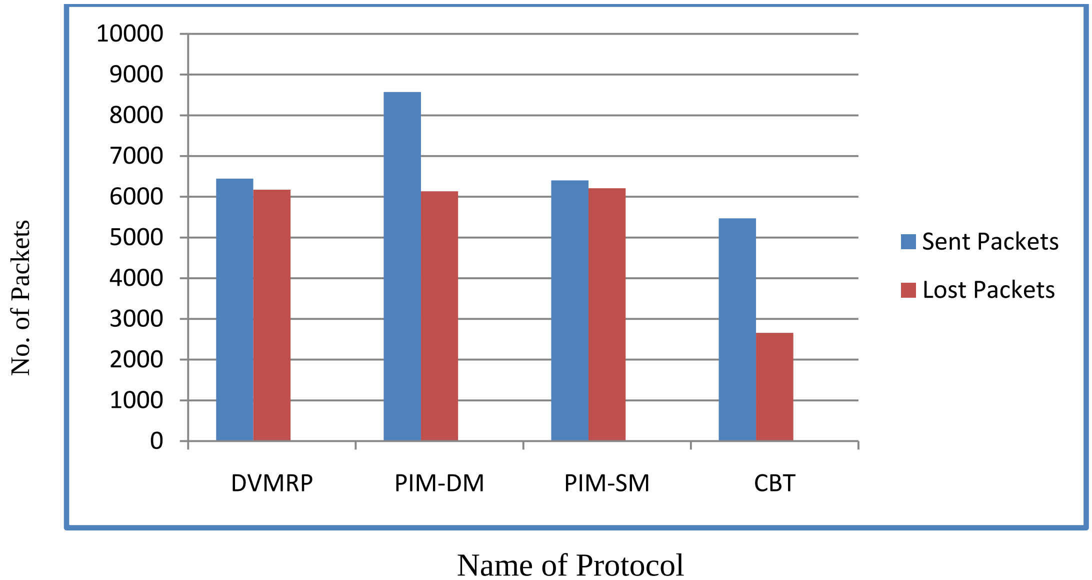


Figure 1.6: Packet Loss (Infra. Based)

The no. of packets that are lost during simulations and can be computed by subtracting the no. of received packets from forwarded packets. The no. of Packets lost by CBT are much less as compared to all another protocols.

Table 1.8: Packet Loss (Infra. Based)

No. of Group Members	Four	Eight	Sixteen	Thirty Two
DVMRP	5317(5373)	6086(6211)	6172(6447)	6180(7626)
PIM-SM	5437(5444)	6184(6195)	6211(6230)	6211(6252)
PIM-DM	5323(5608)	6058(6155)	6136(8572)	6147(11463)
CBT	3411(5435)	4157(6181)	2657(5470)	4186(6210)

In case of ad-hoc only 10 percent as compared to infrastructure based are forwarded.

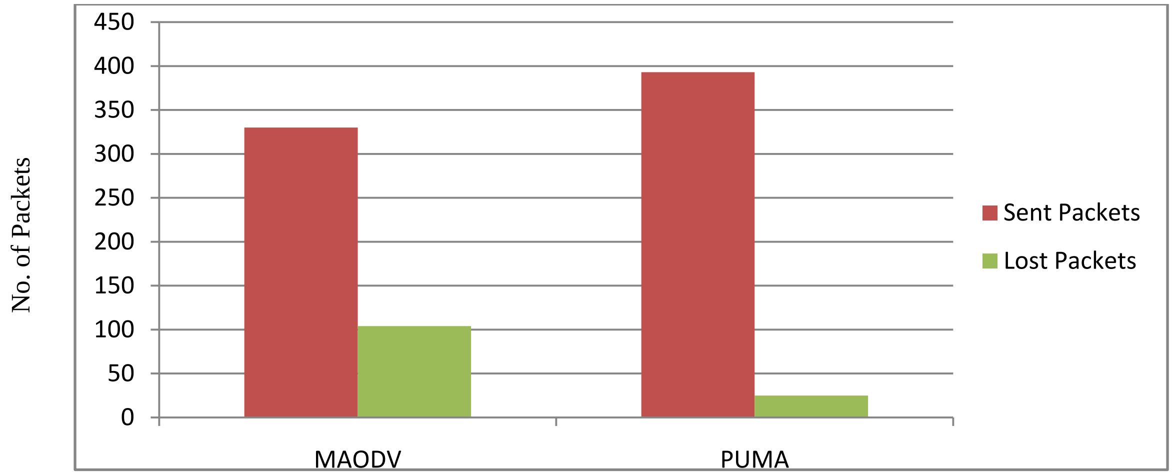


Figure 1.7: Packet Loss (Infra. Less)

The no of packets los by PUMA is one fourth of the packets los by MAODV protocol.

Table 1.9: Packet Loss (Infra. Less)

No. of Group Members	Four	Eight	Sixteen	Thirty Two
MAODV	30(200)	80(320)	100(325)	111(330)
PUMA	10(200)	17(250)	20(380)	25(400)

VII. Conclusion

All multicast routing protocols are different from each other on the basis of performance was measured in terms of performance metrics, there was no convincing Protocol(in all scenarios) in Infrastructure based environment. Therefore, if a network designer is only interested in function of the multicast routing protocols, then he is free to choose any one of the multicast routing protocols, but good performance can not be achieved in all respects.

When Multicast routing protocols are compared on the basis of End to End delay then all protocol shows very different results then PIM-DM give better performance that is less delay, while CBT has maximum delay so it best to choose PIM-DM. Multicast routing protocols performance differed when compared in terms of performance metrics. The experimental results suggest that configuration parameters do indeed play a role in how well the various multicast routing protocols perform. A network designer should be aware of this fact and should choose an appropriate Routing Protocol. In general, in various situations DVMRP and PIM-DM performed similarly to one another in a specific traffic pattern context.

PUMA incurs far less overhead as compared to MAODV. It has higher packet delivery fraction and throughput. The lesser values of End-to-end delay imply a better performance than other protocol. So, PUMA has been selected best from infrastructure less protocols.

References Références Referencias

1. Estrin, D. Farinacci, A. Helmy, V. Jacobson, and L. Wei,(1996) " Protocol Independent Multicast – Dense Mode (PIM-DM): Protocol Specification," Proposed Experimental RFC.
2. T. Ballardie,(1994) "Core Based Tree (CBT) Multicast: Architectural Overview and Specification," Internet Draft RFC.
3. S. Corson and J. Macker, (1999) "Mobile Ad hoc Networking (MANET): Routing Protocol Performance Issues and Evaluation Considerations," IETF Request for Comments 2501.
4. E. M. Royer and C. E. Perkins,(1999) " Multicast operation of the Ad-hoc On-demand Distance Vector routing protocol," Proceedings of ACM/IEEE MOBICOM'99, Seattle, pages 207-218.
5. M. Liu, R. Talpade, A. McAuley, E. Bommaiah, (2000) "Ad-hoc multicast routing protocol,"

Technical Report, CSHCN T. R. 99-1,University of Maryland.
6. C.W. Wu, Y.C. Tay, (1999) "AMRIS: a multicast protocol for ad hoc wireless networks," Proceedings IEEE MILCOM'99, Atlantic City.
7. J.J. Garcia-Luna-Aceves , E.L. Madruga,(1999) "The Core-Assisted Mesh Protocol," The IEEE Journal on Selected Area in Communication, vol.17, no.8, pp1380-1394.
8. S.J. Lee, M. Gerla, C.C. Chiang,(1999) "On Demand Multicast Routing Protocol," Proceedings of IEEE WCNC'99, New Orleans, pages 1298-1302,
9. P. Dhammika, K. Minseok, R-ODMRP (2007) "Resilient On-demand Multicast Routing Protocol," 21st International Conference on Advanced Information Networking and Applications Workshop, vol.2, pp.85-92, 2007
10. Ravindra Vaishampayan and J.J. Garcia-Luna-Aceves, (2004) "Efficient and Robust Multicast Routing in Mobile Ad Hoc Networks," In the Proceeding of first International Conference on Mobile Ad hoc and Sensor Systems (MASS), Florida, USA.

This page is intentionally left blank