Comparative Analysis of Quality of Service of Dense and CBT Mode of Multicast Routing Strategies

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Abstract- The capability of multicasting is an important feature in data networking and is emerging in to a highly demanded service being offered by all major ISPs (Internet Service Providers). The benefits of multicast include reducing the overhead in transmission on the network and sender and reducing data delivery delay for all destinations. Multicast (Point-to-multipoint) refers a communication pattern in which a source node sends a message to a group of destination nodes. The major advantage of multicasting is to decrease the network load. On another hand, multicasting can be very useful in resource discovery. Quality of Services (QoS) is required for most of the multicast application and thus, the constraints for QoS provisioning should be also considered. In this paper we present the analysis and simulation of the performance of existing Dense mode and CBT mode multicast routing algorithms. Therefore, the performance comparison of existing multicast routing protocols over wired mesh networks are essential in order to analyze their behavior effectiveness.

Index Terms- QoS, DVMRP, Multicast

I. Introduction

Suppose a scenario in which a professor wants to conduct a class with 70 students participating through the network. If the multimedia application for that conference used unicasting, the professor's computer repeatedly sends 70 audio streams to the students computer. The wastage of bandwidth has occur in unicasting because in unicasting sends 70 duplicate copies over the network and due to this reason a significant delay before the last student hears the professor's voice. The audio stream could also flood on every node of the network and possibly bring the network down. Multicasting comes to the rescue by allowing the multicast host to send only a single copy of the information and these information received by those hosts that are part of that group. In this class example, the computer of professor sends only single audio stream for the network and only the targeted group of 70 students receive that stream. The minimum required network bandwidth are utilized by that information and arrives at every computer of student without any noticeable delay.[1]

The above example is the practical use of multicasting in everyday life. Some applications, like Internet television, Internet gaming and IP teleconferencing applications require data to be delivered from one or multiple receivers. As illustrated in figure: 1, it is clear that if there are only five receivers of a multimedia application, the utilization of bandwidth between routers can be reduced up to one-fifth if we use multicasting.

The discovery of routes between nodes is done by multicast routing protocols. Multicast has huge impact since it overcomes the overheads of the unicast routing protocol.

II. Taxonomy of Multicast Routing Protocols

The concept of multicasting was launched by Steve Deering [2] in 1980's, early efforts in the 1980's to define a multicast capable Internet resulted in a RFC 966,"Host Groups: A Multicast Extension to the Internet Protocol"(1985). IP multicast concepts evolved through additional RFCs (988 and 1054), resulting in the multicast standard, in RFC 1112, "Host Extension for IP Multicasting"(1989).Additional work in the early 90s led to the creation of Virtual Internet Backbone for Multicast IP or MBone, which was an experimental test bed system for multicast application and protocol development. Mbone was first deployed in 1992 as a virtual network, with application-layer packet replication: one packet in, one or more packets out. From Mbone's flat, virtual set of networks in 1992, all under the same Autonomous System (AS) or domain, multicast routing has evolved from an intra-domain routing emphasis to a broader scope of inter-domain routing in the late 1990's, supporting a hierarchical set of domains.

There are many different types of issues in which the multicast routing protocols are classified into different categories. They can be classified on the basis of how multicast connectivity is established and maintained, whose named is, source-imitated and receiver imitated. In source-imitated approach, the formation of the multicast group is initiated by the source and a tree or mesh is constructed per sender. The source polls the network periodically with join-request packets, the receivers willing to join the multicast group respond with reply packets after receiving the requests. In a receiver imitated approach, a receiver floods a join request packet to search for a path to a multicast group. One important technique used in this approach is to assign a node, known as the Rendezvous Point (RP) or the core, to accept join requests from members. Finally, multicast routing protocols are classified into tree-based and mesh based protocols based on the topology [3] in tree-based protocols, there exists only one possible path between a source-destination pair, whereas in mesh-based protocols, there may exist more than one path. [4]

The classification of existing multicast routing protocols both in wired and wireless networks have been classified based on the topology into source-based tree, shared-based tree and mesh-based protocols. The source-based trees uses

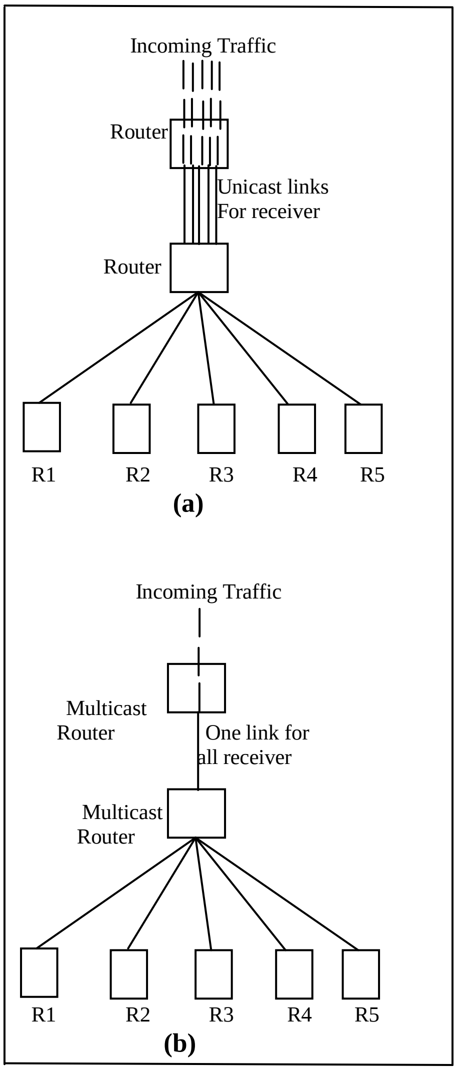

Figure 1: **Delivery of information using multiple unicasting and multicasting.**

The shortest path for minimum delay, these structures are appropriate for regions where group members are densely distributed. On the other hand, shared-based trees have better resource utilization than source-based trees, where increases the traffic concentration. The tree based protocols are more efficient in terms of resource usage and mesh-based protocols are more robust to the changes in the network. The classifications of multicasting routing protocols [4] are described in figure 2:

III. .MULTICASTING IN WIRED NETWORK

The wired multicast routing protocols are defined in two categories: Source-based and Core-based.

Source-Based Multicast Routing Protocol:
A rooted tree is constructing in which root working as a source node and connected to every member in the multicast group. In this protocol data packets are originating from source node and send to all destination nodes through communication link of a multicast tree. The Distance Vector Multicast Routing Protocol (DVMRP)[5], Multicast Extension To Open Shortest Path First Protocol (MOSPF)[6], Protocol Independent Multicast- Dense Mode (PIM-DM)[7], and very recently Explicitly Requested Single-Source Multicast (EXPRESS)[8] comes in the category of source-based trees.

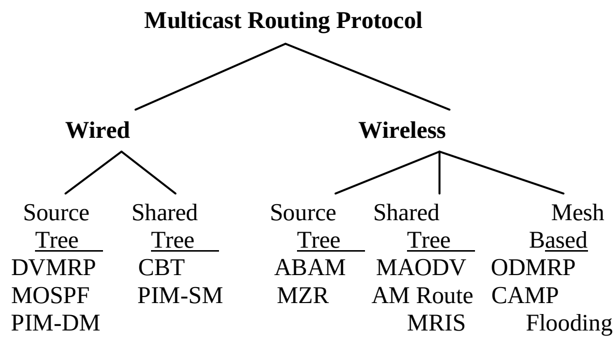

Figure 2: **Classification of Multicast Routing Protocols**

Distance Vector Multicast Routing Protocol (DVMRP):
DVMRP is a source-based multicast routing protocol which uses the Reverse-Path Multicast (RPM) algorithm. DVMRP was first defined in RFC-1075. The original specification was derived from the Routing Information Protocol (RIP) and employed the Truncated Reverse Path Broadcasting (TRPB) algorithm. The major difference between RIP and DVMRP is that RIP is concerned with calculating the next hop to a destination, while DVMRP is concerned with computing the previous hop back to source.
As illustrated in figure: 3, the first packet of multicast message send from a source to a particular multicast group is flooded leaf to the source over the network. Then, prune message send by router are used to truncate the branches which do not lead to a group member. Furthermore, a new type of message is quickly used called "graft". The "graft" message send by the new receiver to the source, which is currently joins that multicast group. Similar to prune message which are forwarded hop by hop, graft message are send back on hop at a time until they reach a node which is on the multicast delivery tree.

Multicast Open Shortest Path First Protocol (MOSPF):
The Multicast extension to OSPF (MOSPF) defined in RFC 1584are built on the top of Open Shortest Path First (OSPF) Version 2 (RFC 1583). MOSPF uses the group membership information obtained through IGMP [9] and with the help of OSPF database builds multicast delivery trees. These trees are Shortest-Path Trees constructed (on demand) for each (source, group) pair. MOSPF supports hierarchical routing. All hosts in the Internet are partitioned in to some "Autonomous System" (AS). Each AS is further divided in to subgroups called "areas".
In OSPF, each router with in a routing domain keeps state and topological information of this domain, this is achieved

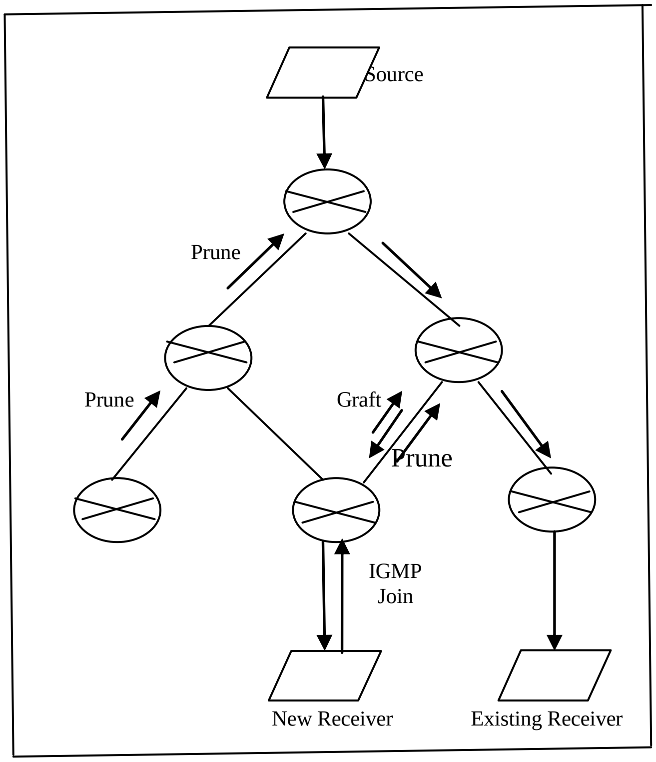

Figure 3: **Message flowing in DVMRP**

by link-state advertisement (LSA) flooding. A shortest path tree rooted at the source using Dijkstra's algorithm has builded by MOSPF router. After the building of tree, group membership information is used for pruning for those branches that do not lead to sub networks with group members. Resulting, a pruned Shortest-path tree in which source as a route. The MOSPF router creates a forwarding table and then determines its position in the shortest-path tree. The forwarding table is not changing after a fixed interval but when the network topology or group membership have changed the forwarding table has also changed.

Protocol Independent Multicasting-Dense Mode (PIM-DM):
PIM contains two protocols: PIM-Dense Mode(PIM-DM) which performs better in cases where the group members are densely distributed and PIM-Sparse Mode(PIM-SM) which is more efficient when the group members are distributed over many regions of the network. PIM-DM is very similar to the DVMRP in that it requires the presence of unicast routing protocol for finding routes back to the source node. The other difference between PIM-DM and DVMRP is that PIM-DM forwards multicast message to all downstream hosts until it received a prune message, while DVMRP forwards multicast traffic to child nodes in the delivery tree. PIM-DM Different from DVMRP and MOSPF Protocols; DVMRP uses RIP like exchange message to build its unicast routing table, and MOSPF relies on OSPF link state database.

EXPRESS: Holbrook etc al [10] proposed an extension of IP multicasting to support large-scale single-source applications. The writer described a realization of channel model called Explicitly Requested Single-Source Multicast (EXPRESS) on the top of multicast [10]. It uses an EXPRESS Count Management Protocol (ECMP) for both maintaining the multicast tree and supporting the source-directed counting. ECMP generalizes the join/leave function by using to count the number of subscribers in a sub tree. In this, a new subscriber sends a *subscriber ID Count* message to the next hop through the shortest-path to channel source. The *subscriber ID Count* message moves from hop to hop until it reaches to the source. A host unsubscribed by sending a zero count message upstream. Count values are kept by routers and updated when a subscriber joins/leaves. When the network topology changes then the router select a different upstream router for a channel, and it sends a current count message to the new upstream router and a zero count message to the old upstream router unsubscribed it there [10].

Core-Based Multicast Routing Protocol:
One node is selected for each group called core or rendezvous point (RP) [11,12]. A root of the tree defined as a core is then constructed to span all the group members. The Core-Based Tree (CBT) Protocol [13], PIM-Sparse Mode (PIM-SM)1 [14] and very recently Simple Multicast (SM) [15] are comes in the core-based multicasting routing protocols.

Protocol Independent Multicasting-Sparse Mode (PIM-SM):
PIM-SM which is defined in RFC 2117, has two major differences with dense mode protocols (DVMRP,MOSPF, and PIM-DM). In PIM-SM protocol the routers need to explicitly announce their will for receiving multicast message of multicast group [16], while in dense mode protocols suppose that, all routers have needed to receive multicast message unless explicitly prune message has send. The other difference is the concept of "Rendezvous Point" (RP) or "Core" which has been used in PIM-SM protocol.

In PIM-SM assigning a set of RPs for each group, where one RP is working as a Primary RP and it is responsible for forwarding all the packets. If any routers want to receive multicast message from another group then it needs to send a join message to RP of that group. Each Of the multicast host has a designated router (DR), which manages the multicast group membership messages in its group. If any host in its group wants to join another group it sends a join message to the DR, when DR receives an IGMP messages, which indicates the membership of a host to a certain group then DR finds the RP of that group with the help of performing a deterministic hash function on the sparse-mode region's RP-sets and unicast-PIM join message forwarding to the RP. The entry is created in the multicast forwarding table of the DR and intermediate routes for the (source, group) pair, such that they can know how to forward multicast message coming from RP of that multicast group to the DR and group members [16]. If the source node wants to send a message to a certain group, then it has to first register itself with the RP sending through a PIM-SM-Register message. The DR of that source encapsulates this message and sends it towards the RP of that group as a unicast message. After that the RP sending back a PIM-Join message to the DR of the source.

Although, PIM-SM is based on the shared tree , it provides a method for shortest-path trees on the behalf of receivers. After joining a shared tree, if a receiver finds another optimal route to the source, it sends a join message towards the active source [2]. After constructing the source-based shortest path tree, the router can sends a prune message to the RP and hence disassociates itself from the shared tree.

Core-Based Tree (CBT) Mode: The latest algorithm developed for constructing multicast deliver tree called core-based tree (CBT) algorithm. A single delivery tree is created by multicast CBT for each group. The "Core" router for a delivery tree is chosen by single or a set of routers. All messages are forwarded as unicast messages towards the core router until they reached a router which belongs to the corresponding delivery tree. After that the message is forwarded to all ongoing interfaces except the incoming interfaces. This has been described in fig: 3.

The multicast routers have required to keep less information as compared to the requirement of other routing algorithms. CBT preserves more network bandwidth because it has not required flooding for any multicast packet. Although, using a single tree for each group may lead to traffic concentration around the core routers.

Simple Multicast (SM): Perlman et al [15] proposed a multicast routing protocol called Simple Multicast, which extends CBT and works both within and between domains. SM [15] appears CBT in terms of member join/leave, tree maintenance and data transfer. The main difference between CBT and SM is that how they resolve the multicast address allocation problems. SM identifies a group by the 8-byte combination of a core node and the multicast addresses [16].

IV. Experimental Results

The snapshots of my experiment of both multicasting routing algorithm i.e. Dense mode and Core-based tree mode multicasting routing protocol are shown in below figure: 4 and figure: 5 and the results of my experiment are shown in figure: 6, figure: 7 and figure: 8.

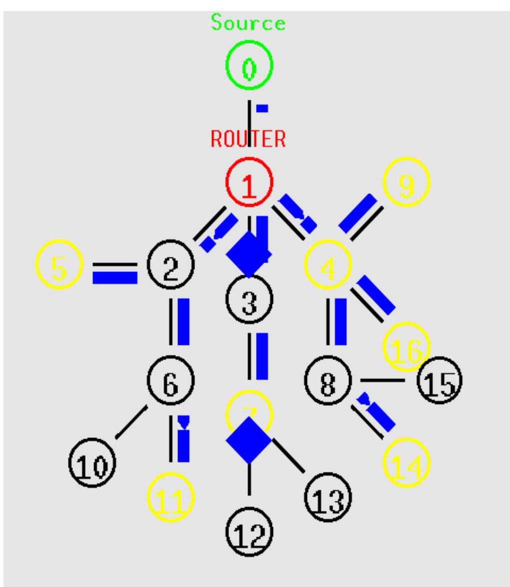

Figure 4 : Data transmission using Dense Mode

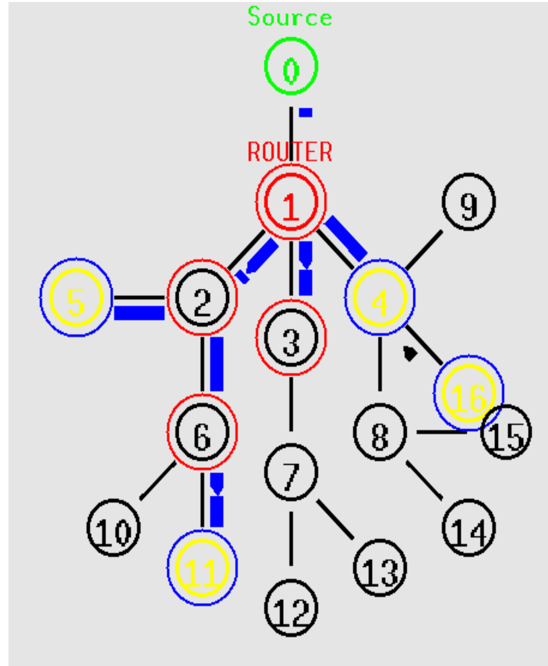

Figure **5**: Data transmission using CBT Mode

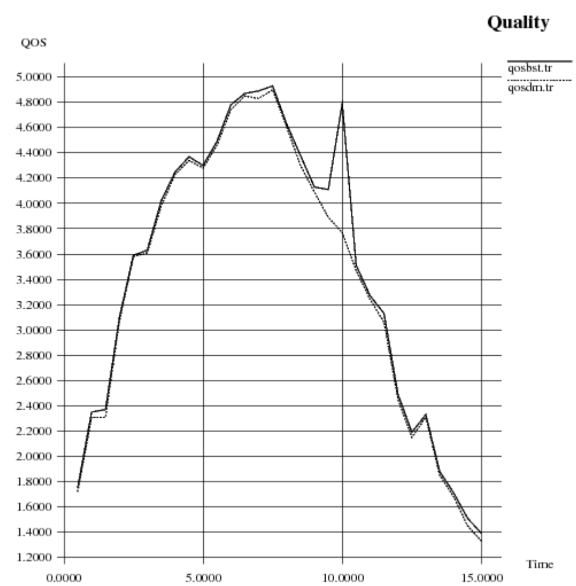

Figure 6: Graph For Quality Of Services

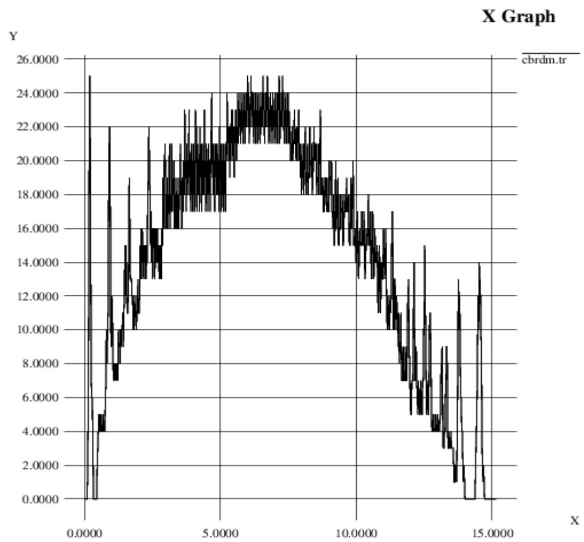

Figure 7: Performance Of Dense Mode Showing time-interval on x-axis and number of packets on y-axis

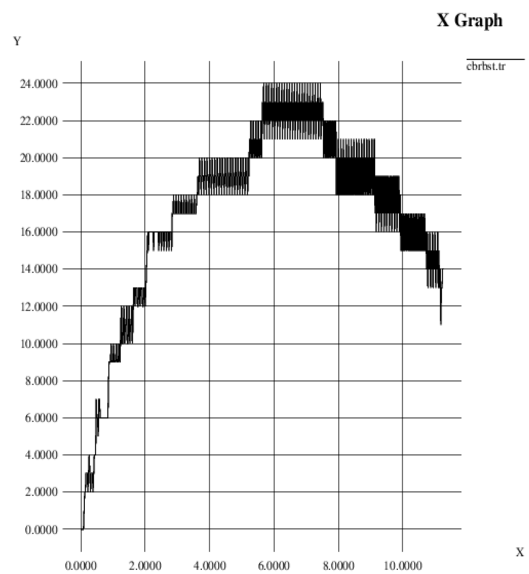

Figure 8: Performance Of CBT Mode Showing time-interval on x-axis and number of packets on y-axis

V. CONCLUSION

In this paper I have implemented the dense mode and Core-Based Tree Multicast routing protocols, in tool command language and integrated the module in the ns-2 Simulator. The performance of the protocols were measured with respect to metrics like Packet delivery ratio, end – end delay etc. I have made the performance and quality of services (QoS) comparison of the protocols. Simulations were carried out with identical networks and running different protocols on the mobile node. The results of the simulation indicate that performance and QoS of the Core-based tree mode multicasting routing protocol is better than the Dense mode multicasting routing protocol.

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