Prototypical Assessment of PIM-DM, DVMRP, CTR and BST Multicasting Modes

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ABSTRACT
The paper contrast a Multicasting network using PIM-DM (Protocol Independent Multicast - Dense Mode), DVMRP (Distance Vector Multicast Routing Protocol), CTR (Centralized Tree) and BST (Bi-Directional Shared Tree) protocols using NS2. The networking topology is well analyzed to record number of packets send, average throughput, average delay, average jitter, and average path. The simulation results mark that BST is better in terms of packet sent as compare to others and hence has high throughput value. It is also good in terms of average path that is it covers less number of hops. But when talking about average jitter and average delay it is not considered good, in these two cases CTR works well.

Keywords – PIM-DM, DVMRP, CTR, BST, Multicasting, NS2.

I. INTRODUCTION
Steeve Deering et al. in 1986 developed an approach in which a single source can transmit a message to multiple receivers simultaneously; this is called as multicast [1, 2]. He initially used MBONE to develop multicasting between sites through the use of tunnels and further renewed his approach to make the service available to a wide array of end users [3]. It is a stateful service in that it requires routers to maintain state for forwarding multicast data toward receivers [4, 15]. It is a widely used service in today’s computer networking system and mostly used in Streaming media, Internet television, videoconferencing and net meeting. To carry out multicasting numbers of multicast routing protocols are available. These protocols depend upon multicast routing strategies. These can be easily studied with the help of NS2 [5].

1. Multicast route computation strategies for the wire-line network: It is the mechanism which supports the creation of the multicast distribution tree in the simulation. NS supports four route computation strategies: centralized, dense mode (DM), shared tree mode (ST), bidirectional shared tree mode (BST). This route creation strategies are specified to the simulator using mrptproto{} method. And to enable multicast support in simulator following commands are required:

```
set ns [new Simulator]
set ns multicast
```

1.1 Dense Mode (DM): It can activate two modes which depend on the value of DM class variable CacheMissMode. If CacheMissMode is set to pimdmc (default), PIM-DM [6,7] like forwarding rules will be used. Alternatively, CacheMissMode can be set to DVMRP [8]. The main difference between these two modes is that DVMRP maintains parent–child relationships among nodes to reduce the number of links over which data packets are broadcast.

1.2 Centralized multicast (CM): The centralised multicast is a sparse mode implementation of multicast similar to PIM-SM [9, 10] or CBT [11, 12]. In this a Rendezvous Point (RP) rooted shared tree is built for a multicast group. It implements two types of multicast trees, the default one is the RPT tree with rendezvous point (RP), the other is SPT tree that consists of a source specific shortest path tree. The user can choose between these two tree types depending upon application requirements [13].

1.3 Shared Tree Mode (ST): It is a simplified sparse mode implementation of the shared tree (with RP) multicast protocol.

1.4 Bi-directional Shared Tree Mode: It is an implementation of the shared tree with bidirectional capability [14].

These different modes cover almost all types of multicast routing protocol like DVMRP, PIMDM, CBT,
II. SYSTEM DESCRIPTION

2.1. Topology
A network of 20 nodes is created and UDP protocol is used to send constant bit rate (cbr) packets. Here source node is considered at node 1. From this node packets are sent to particular group nodes. Types of packets transmitted are: neighbor probe, route discover, prune message and graft message. Neighbor probe and route discover are black in color, prune messages has purple color and graft messages has green color. Initially there is no node in a multicast group and with time some nodes join the group using join-group ns command and some leave using leave-group. In this topology all node are multicast capable nodes. Each node has it capacity i.e. has well defined queue length, if this length is exceeded then the node starts dropping packets. This situation is as a result of increase in number of packets in the network. We have used Fig. 1 as a common topology to deal with all multicasting modes. Among these modes PIMDM and DVMRP are simple routing protocols but in case of CTR and BST there is a need of a central node i.e. Rendezvous point (RP). For CTR RP, is at node 5 and for BST at node 2.

![Figure 1: Common Network Topology Design](image)

2.2 PIM-DM (Protocol Independent Multicast – Dense Mode)
PIM-DM [6, 7] is a source – based tree routing protocol that uses RPF, pruning and grafting strategies for multicasting. Its operation is like that of DVMRP; however, unlike DVMRP, it does not depend on a specific uncasting protocol. It assumes that the autonomous system is using a unicast protocol and each router has a table that can find the outgoing interface that has an optimal path to a destination. This unicast protocol can be a distance vector protocol or link state protocol. It is envisioned that PIM-DM will be deployed in resource-rich environments, such as a campus LAN where group membership is relatively dense and bandwidth is readily available.

**PIM DM protocol works in two phases:**
In the first phase, the whole network is flooded with multicast data and this is done by propagation of packet on all interfaces except on upstream interface. This phase is highly inefficient because it leads to excessive network resource usage because of its network flooding technique.

In the second stage, unnecessary branches are cut down by means of a Prune message. A network device, after reception of a prune packet, terminates further forwarding of multicast traffic on this interface and the interface is set to be in prune state.

**Command used for Configuring PIM-DM**
Set group [Node allocaddr]
set mproto DM

2.3 DVMRP (Distance Vector Multicast Routing Protocol)
The distance vector multicast routing protocol [8] is an implementation of multicast distance vector routing. It builds a multicast tree for each source and destination host group. It implements the Reverse Path Multicasting (RPM) algorithm. It is a source based routing protocol, based on RIP, but the router never actually makes a routing table but it uses unicast routing protocol for this purpose. When a router receives a multicast packet it forwards (broadcast) it. DVMRP uses a Broadcast & Prune mechanism. That is, a broadcast tree is build from a source by exchanging routing information. Then this broadcast tree is changed to multicast tree by using pruning technique. More specifically, initially multicast datagram’s are delivered to all nodes on the tree. Those leaves that do not have any group members send prune messages to the upstream router, noting the absence of a group. The upstream router maintains a prune state for this group for the given sender. A prune state is aged out after a given configurable interval, allowing multicaasts to resume. Pruned branches are restored to a multicast tree by sending graft messages towards the upstream router. Graft messages start at the leaf node and travel up the tree, first sending the message to its neighbor.
upstream router. Thus it works on broadcasting, pruning and grafting process.

**Command used for Configuring DVMRP**
set group [Node allocaddr]
DM set CacheMissMode dvmrp
set mproto DM

2.4 CTR mode supports mainly following two types of multicast routing protocol.

2.4.1 PIM-SM (Protocol Independent Multicast-Sparse Mode)
PIM-SM [9, 10] is a group-shared tree routing protocol that has a rendezvous point (RP) as the source of the tree. Its operation is like CBT; however, it is simpler because it does not require acknowledgement from a join message. In addition, it creates a backup set of RPs for each region to cover RP failures. PIM-SM creates and maintains unidirectional multicast trees based on explicit Join/Prune protocol messages. PIM-SM is designed to support sparse groups. PIM-SM creates a shared, RP-routed distribution tree that reaches all group members and it authorizes the receivers to switch from a RP (Rendezvous Point)-routed tree (RPT) to a shortest path tree (SPT).

**It works in following phases:**
The phase one of the protocol formulates a distribution tree for multicast.
The second phase of PIM-SM operation is the Register STOP operation.
The third phase of protocol is the formation of Shortest Path Tree (SPT).

2.4.2 CBT (Core Based Tree)
CBT [11, 12] was first proposed by Ballardie, Francis, and Crowcroft. It floods the data or the membership information from the multicast group address to a particular unicast address (core address) of a router (Core Router), and build explicit distribution trees centered on this particular router. It has a single Core Tree per group.

**Working of CBT**
1. Identification of Core Router: Selection of core should be done carefully. A router could become a core when a host on one of its attached subnets wishes to initiate a group. Or in case of a single sender, the router nearest to it could become a core.

2. Formation of tree: After the rendezvous point (core) is selected, every router is informed of the unicast address of the selected router. Each router then sends a unicast join message (similar to a grafting message) to show that it wants to join the group. This message passes through all the routers that are located between the sender and rendezvous router. Thus results in the formation of a tree.
3. **Sending multicast packets:** After formation of the tree, any source can send a multicast packet to all members of the group. It simply sends the packets to the rendezvous router; this router distributes the packets to all the members of the group.

**Commands used for configuring CTR:**
set group [Node allocaddr]
set mproto CtrMcast
$mrthandle set_c_rp $n(5)
In BST simulation we have set node 2 as RP to maintain state table.

2.5 BST (Bidirectional Shared Tree)
BST is a multicasting protocol implemented in NS2 is in Research mode. In BST, multicast data can travel in both the direction of tree for each receiver [14]. When receivers are distributed throughout the network it gives the better result than other. Bidirectional trees offer improved routing optimality by being able to forward data in both directions while retaining a minimum amount of state information. RP used in this system is used to maintain the routing table for the upstream and downstream receivers. All the data is sent to the RP and RP then forwards it to the receivers using minimal path.

**Commands used for configuring BST:**
set group [Node allocaddr]
BST set RP_($group) $n(2)
$ns mrtpproto BST
In BST simulation we have set node 2 as RP to maintain state table.

**III. PERFORMANCE EVALUATION**

Here we have measured and compared the different performance parameters of multicasting strategy modes i.e. PIM-DM, DVMRP, CBT, BST in static network with the help of NS2 and finally plotted bar and line graphs. Performance parameters used for comparison are:

1. **Throughput:** It is the rate at which packets can be delivered successfully from one location to another in a
given amount of time. It can be represented in terms of ratio of packets sent per unit time or in terms of ratio of bytes sent per unit time. Time is represented in seconds.

Fig. 2 and 3 shows the throughput in terms of Packets/Second and Bytes/Second respectively for discussed protocols in terms of line graph. This shows that BST has better throughput as compared to others on the other hand CTR has low throughput value.

Fig. 4 shows the throughput in terms of Bytes/Second for discussed protocols in terms of bar graph. This shows that BST has better throughput as compared to other on the other hand CTR has low throughput value.

2. Average Delay: It refers to the time taken for a packet to be transmitted across a network from source to destination.

Fig. 5 shows the average end to end delay of discussed protocols in terms of bar graph. This shows that CTR takes less time to deliver a packet as it has less delay value.

3. Average Jitter: It refers as a variation in delay with respect to some definition rate or time.
Fig. 6 shows the average jitter of discussed protocols in terms of bar graph. This shows that CTR has less variation in delay on the other hand PIMDM has more.

4. **Number of Packets Send:** It is simply the rate of transmission of number of packets.

Fig. 7 shows the numbers of packets send by discussed protocols. This shows that transmission rate of BST is better than all others on the other hand CTR has very low transmission rate.

5. **Average Path:** It includes the number of hops covered for packet transmission to its destination.

Fig. 8 shows the average path of discussed protocols in terms of bar graph. This shows that BST has less number to hops to traverse as compared to other on the other hand PIMDM has large number of hops to cover.

IV. **SIMULATION RESULTS**

<table>
<thead>
<tr>
<th>Multicast Modes</th>
<th>PIMDM</th>
<th>DVMRP</th>
<th>CTR</th>
<th>BST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput (Bytes/Second)</td>
<td>87491.25</td>
<td>87622.5</td>
<td>28245</td>
<td>88200</td>
</tr>
<tr>
<td>Average End to End Delay</td>
<td>0.44069 2</td>
<td>0.41228 5</td>
<td>0.26177 8</td>
<td>0.35007 2</td>
</tr>
<tr>
<td>Average Jitter</td>
<td>0.29729 7</td>
<td>0.28503 6</td>
<td>0.10103 2</td>
<td>0.28866 3</td>
</tr>
<tr>
<td>Number of Packets Send</td>
<td>2838</td>
<td>3399</td>
<td>1316</td>
<td>3921</td>
</tr>
<tr>
<td>Average Path</td>
<td>6.48874 9</td>
<td>4.96195 3</td>
<td>5.60037 2</td>
<td>3.17559 5</td>
</tr>
</tbody>
</table>

This table is formulated by using NS simulator. For this we ran the simulator for 7.5 sec for 20 nodes and for different protocols as PIMDM, DVMRP, CTR, and BST. The results obtained are in form of values in terms of seconds for different parameters. On analyzing these values we came to know that BST outperforms all these.
protocol modes. These obtained values are plotted in terms of bar and line graph in section 3.

V. CONCLUSION

This paper compares the multicasting protocols using NS2 simulation tool on the basis of different performance parameters as throughput, average end to end delay, average jitter, number of packets send and average path. We concluded that the throughput and number of packets send by BST network is mark ably high and its average path is also low but when talking about average delay and average jitter CTR outperforms it. So on the basis of overall comparison BST performs well for our work.

REFERENCES