Dense, Centralized and BST Mode of Multicast Routing Strategies in Wired Networks

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Abstract  
Multicast routing is a kind of communication whose motive is to send data to all the receivers which belong to a multicast group, while attempting to employ the available bandwidth effectively; it also reduces the communication price and saves the network resources. In this paper, we compared the Dense, Centralized and BST mode of multicast routing strategies in wired networks.

Keywords: Wired networks; PIM-DM; DVMRP; CTR; BST; Multicasting.

1. INTRODUCTION  
1.1. Wired Network

In computing terminology, the term "wired" is used to distinguish between wireless connections and those which are used cables for connections. Wired networks, are also known as Ethernet networks, which uses physical cables to transfer data between different devices and computers. It is the most common type of local area network (LAN) technology. It is just an assembling of two or more computers, printers, and other devices linked by Ethernet cables. In a small wired network, a single router may be used to connect all the computers, but larger networks involve multiple routers or switches that attach to each other [10, 12].
Wired networks have various salient features:

1. Changes in network topology are really uncommon.
2. Rich link capability.
3. High bandwidth.
4. Apply cable to connect computers.
5. Wired networks can also be employed as a component of other wired and wireless networks.
6. Range of wired network is inside a 2,000-foot-radius.
7. The weakness of this is that data transmission over this distance may be slow and nonexistent.
8. Interference is very limited through straight connections.
10. Can be employed in many situations; school networks, hospitals and corporate LANs.
11. The biggest disadvantage to this type of network is that it must be rewired every time it is acted.
13. Firewalls are the main security deliberation.
14. The cost of wired networking has become quite cheap. Ethernet cables, switches and hubs are not expensive.
15. High reliability.
16. Less connection setup time.
17. Better quality of service.
18. Less signal loss and fading.

1.2. Type of Transmission

**Broadcast:** It refers to one-to-all transmission, i.e. one source sends messages or data packets to all destinations in the network. This is the easiest way of transmission to guarantee traffic reaches to its destination [11].

**Unicast:** It refers to one-to-one transmission, i.e. one source sends messages or data packets to one destination. This is the most ordinary approach and builds the foundation for another type of protocols. Unicast protocols insulate when there is a need to transmit same message or flow of data to many destinations [2].

**Multicast:** It refers to one-to-many or many-to-many transmission, i.e. source sends messages or data packets to numerous destinations and has a suitable routing tree or a mesh from one source to numerous destinations. These protocols have to stay up with information of joining and leaving of nodes in a multicast group [14].
1.3. Multicasting

Steeve Deering et al. in 1986 evolved an approach in which a single source can send a message to multiple destinations at the same time; this is known as multicast [13]. Multicast [8] is a network treating with a method for the delivery of information to a group of target simultaneously using the most effective strategy to transmit the messages over every link of the network simply once, preparing copies only when the connections to the multiple destinations disunite. It grants saving bandwidth and falling the traffic load in the network. It also offers seamless and continuous streaming services, and generally used in streaming media, net meeting, Internet television and video conferencing, etc.

Multicasting decrease the communication costs for functions that transmit the same data to multiple receivers. Instead of transmitting via multiple unicasts, multicasting reduces the link bandwidth ingestion, sender and router dispensation, and delivery delay. The first support required for multicasting is: Multicast-capable routers (MRouters), Dedicated Tunnels and Multicast backbone (MBone).

1.4. Multicast route computation schemes for the wired networks

It is the mechanism which supports the formation of the multicast distribution tree in the simulation. NS [9] supports four route computation schemes: dense mode (DM), centralized multicast (CM), shared tree mode (ST) and bidirectional shared tree mode (BST).

1.4.1. Dense Mode (DM)

It can activate two modes which based on the value of DM class variable CacheMissMode. If CacheMissMode is set to pimdm (by default), PIM-DM-like forwarding rules are used. Or else, CacheMissMode can be set to dvmrp. The primary difference between these two modes is that dvmrp keeps parent-child kinships among nodes to bring down the number of links over which data packets are broadcast.

1.4.2. Centralized Multicast (CM)

The centralized multicast is a sparse mode execution of multicast alike to PIM-SM or CBT. In this a Rendezvous Point (RP) rooted shared tree is made for a multicast group. It executes two types of multicast trees, the default one is the RPT tree (with RP), the other is SPT tree that is made up of a source specific shortest path tree. The user can select between these two tree types depending upon application necessities.
1.4.3. Shared Tree Mode (ST)

It is a simplified sparse mode execution of the shared tree (with RP) multicast protocol.

1.4.4. Bi-directional Shared Tree Mode (BST)

It is an execution of the shared tree with bidirectional capability.

These four modes cover almost all types of multicast routing protocol like PIM-DM, DVMRP, PIM-SM, CBT, and Bidir-PIM etc. with only minor alterations.

2. RELATED WORK

There are enormous works on Multicasting protocols with performance parameters such as packet delivery ratio, throughput and end-to-end delay.

Navpreet Kaur and Sangeeta Monga compare the performance of wired and wireless networks on the basis of several parameters such as speed, security, mobility, reliability, cost, etc. And they concluded that Wired Network has high reliability, high speed and bandwidth, more secure and limited mobility as compared to Wireless Networks [10].

Manish Kumar Tiwari and S.S. Gautam discussed about the multicast routing protocols in wired networks. They have discussed the strengths and weaknesses, trade-offs and properties of multicast routing protocols. They concluded that the selection of multicast routing protocol depends upon the nature of application [7].

Shalu Sraw and Gupreet Singh compares the different multicasting modes (DM, CTR, BST) on the basis of different performance parameters such as throughput, average jitter, number of packets send, average path, average end-to-end delay and average jitter. They concluded that BST has high throughput value, better in terms of number of packets sent and good in terms of average path. And CTR is good in terms of average jitter and average delay [15].

Ankur Dubey and Akhilesh Kosta compares the Centralized, Dense and BST mode of multicast routing strategies on the basis of various performance parameters such as Packet Delivery Ratio (PDR), average end-to-to delay, and drop ratio. They concluded that Dense mode is better in terms of a PDR as compared to Centralized and BST as the no. of receivers are increased, BST has highest PDR when no. of receivers are decreased, BST has lower delay and lower drop ratio as compared to the Dense and Centralized mode [16].

In this paper, we presented the comparative analysis of Dense, Centralized and BST mode of multicast routing strategies.
3. MULTICAST ROUTING PROTOCOLS

3.1. Protocol Independent Multicast- Dense Mode (PIM-DM)

PIM-DM [1] is a source-established tree routing protocol that practices RPF and pruning and grafting schemes for multicasting. Its procedure is like that of DVMRP; however, unlike DVMRP, it does not depend on a particular unicasting protocol. It imagines that the independent system is employing a unicast protocol and each router has a table to discover the outgoing interface that has an optimal path to a target. This unicast protocol can be a link state protocol, or distance vector protocol.

It is visualized that PIM-DM will be deployed in resource-rich surroundings, such as a campus LAN where group membership is comparatively dense and bandwidth is readily obtainable.

PIM-DM protocol acts in two phases:

In the maiden phase, the entire network is flooded with multicast data and this is done by propagation of packet on all interfaces except on the upstream interface. This phase is extremely ineffective because it directs to extreme network resource usage because of its network overflowing technique.

In the second phase, called a prune phase, it cuts out unneeded branches by means of a Prune message. A network machine, after a reception of a Prune packet, stops further forwarding of multicast traffic on this interface and the interface is set to be in prune state.

There is a significant message that is periodically exchanged between PIM-DM routers are Hello packets. It aids routers learn regarding the presence of PIM DM-capable neighbor routers in the network.

3.2. Distance Vector Multicast Routing Protocol (DVMRP)

The distance vector multicast routing protocol [6] is an execution of multicast distance vector routing. DVMRP constructs a multicast tree for each source and target host group. It enforces the Reverse Path Multicasting (RPM) algorithm. It is a source established routing protocol, based on RIP, but the router never actually creates a routing table, but it practices a unicast routing protocol for this reason.

When a router receives a multicast packet it onwards (broadcast) it. DVMRP employs a Broadcast & Prune mechanism. That is, a broadcast tree is made from a source by interchanging routing information. Then this broadcast tree is altered to multicast tree by employing a pruning technique. More specifically, originally multicast datagram’s are broadcast to all nodes on the tree. Those leaves that do not have any group
members transmit prune messages to the upstream router, noticing the absence of a group. The upstream router keeps a prune state for this group for the given transmitter. A prune state is old out afterward a given configurable interval, permitting multicasts to resume. Pruned branches are restored to a multicast tree by transmitting graft messages towards the upstream router. Graft messages begin at the leaf node and travel up the tree, first transmitting the message to its neighbor upstream router. Thus, it acts on broadcasting, pruning and grafting process.

3.3. Centralized (CTR) mode supports two types of multicast routing protocol are as follows.

3.3.1. Protocol Independent Multicast-Sparse Mode (PIM-SM)

PIM-SM [4, 5] is a group-shared tree routing protocol that has a rendezvous point (RP) as the root of the tree. Its procedure is like CBT; however, it is simpler because it does not need acknowledgement from a join message. In addition, it produces a backup set of RPs for each area to cover RP failures. PIM-SM makes and keeps unidirectional multicast trees established on explicit Join/Prune protocol messages. It is planned to support sparse groups. PIM-SM makes a shared, RP-routed distribution tree that arrives at all group members and it empowers the receivers to swap from a Rendezvous Point Tree (RPT or RP-tree) to a Shortest Path Tree (SPT).

It acts in following phases:

In the primary phase, it develops a distribution tree for multicast. The receiver elects one local router as a Designated Router (DR) for its contained subnet. All the DR’s transmits JOIN messages [in the form of (*, G)] towards the RP for multicast communications. When many receivers join the group, then their join messages meet at the performing distribution tree. This is known as RP-tree (RPT) and is a shared tree as it is shared by all the sources transmitting to the group. The Multicast sender transmits the multicast data to the group through the DR. The DR Unicasts encapsulates the data and transmits them to the RP. This process is known as Registering. The encapsulated packets are known as PIM Register Packets. RP decapsulated the data and forwards them to the signified shared tree and repeats wherever the RP Tree branches, and finally arriving at all the receivers for that multicast group.

In the second phase, called a Register STOP phase, the encapsulation and decapsulation procedure at the router may be expensive. Hence, when the RP gets a register encapsulated data packet from source S to group G, it will usually start an (S,
G) source specific Join towards S and RP will swap to native forwarding. Finally the messages arrive at the subnet S and the packets streaming towards the RP. While RP is in the procedure of joining source specific packets, data packets proceed to encapsulate to RP. Thus RP gets packets forwarded natively from S as well as encapsulated packets. RP now starts to discard the encapsulated copy of the packets and transmits a Register STOP message to DR of the source S.

In the third phase, it forms a Shortest Path Tree (SPT). This phase gives optimized forwarding paths. This is done to attain low latency and effective bandwidth utilization. The route through RP may not always be optimal. It may cause important time lags by detouring of paths. DR may start a transfer from shared tree to source specific SPT by using an (S, G) join message. Data packets, then flow from S to the receiving nodes succeeding the (S, G) entry. Thus the receiver gets two copies of data, one following RPT and another from SPT. When traffic starts coming from SPT, it transmits a PRUNE message towards the RP known as (S, G, rpt) prune. It keeps state showing that the traffic from S for G should not be propagated in that way. Thus the shortest path tree is made.

3.3.2. Core Based Tree (CBT)

CBT [3] was first advised by Ballardie, Crowcroft, and Francis. It overflows the data or the membership information from the multicast group address to a specific unicast address (core address) of a router (Core Router), and form explicit distribution trees focused on this specific router. It has a one Core Tree per group.

It works in following steps:

(1) Designation of Core Router: Selection of core should be done cautiously. A router could become a core when a host on one of its connected subnets wants to start a group. Or in case of an individual sender, the router closest to it could become a core.

(2) Constitution of tree: Afterward the rendezvous point (core) is chosen, every router is informed of the unicast address of the chosen route. Every router then transmits a unicast join message (alike to a grafting message) to indicate that it wishes to join the group. This message goes through all the routers that are placed between the sender and rendezvous router. Thus its outcomes in the constitution of a tree.

(3) Transmitting multicast packets: After the constitution of the tree, any source can transmit a multicast packet to all members of the group. It merely transmits the packets to the rendezvous router; this router circulates the packets to all the members of the group.
1.4. BST (Bidirectional Shared Tree)
BST is a multicasting protocol implemented in NS2 is in research manner. In BST, multicast data can move in both the direction of a tree for each receiver. When receivers are distributed throughout the network it yields the improved result than another. Bidirectional trees provide bettered routing optimality by being capable to forward data in both directions while retaining a minimum quantity of state information. RP employed in this system is employed to keep the routing table for the upstream and downstream receivers. All the data are transmitted to the RP and RP then onwards is to the receivers employing the minimal path.

4. COMPARISON BETWEEN DENSE, CENTRALIZED AND BST MODE
Comparison of Dense, Centralized and BST mode of multicast routing strategies is as follows:

(1) Throughput: It is the ratio of packets delivered successfully from source to destination per unit time.

BST has higher throughput value as compared to both Dense and Centralized modes. Dense mode has higher throughput value than Centralized mode.

(2) Average path: It is the number of nodes traversed for packet transmission to its destination.

BST has better in terms of average path as compared to both Dense and Centralized modes. Centralized mode has better average path value than dense mode.

(3) Packet Delivery Ratio (PDR): It is the ratio of number of received data packets to the number of generating data packets. Dense mode has a better PDR as compared to both Centralized and BST modes as the numbers of receivers are increasing. BST has higher PDR as the numbers of receivers are decreasing.

(4) Average End-to-End delay: It is the average time which is required to traverse from source to destination in a network. Centralized mode has better (lower) delay as compared to both Dense and Centralized modes.

(5) No. of Packets send: It is merely the rate of transmission of a number of packets.

BST has higher transmission rate as compared to both Dense and Centralized modes. Dense mode has a higher transmission rate as compared to Centralized mode.

(6) Drop Ratio: It is the ratio of packets lost to the packets sent.

BST has better (lower) drop ratio as compared to both Dense and Centralized modes. Centralized mode has a higher drop ratio as compared to dense mode.
(7) Average Jitter: It is a variation in delay with respect to some given time. Centralized mode has better (lower) average jitter value as compared to both Dense and BST. Dense mode has better average jitter value as compared to BST mode.

5. CONCLUSION
In this paper, we have reviewed Dense, Centralized and BST mode of multicast routing strategies in wired networks and also compare them on the basis of various performance parameters like throughput, average jitter, average delay, average path, drop ratio, packet send, and packet delivery ratio. We concluded that BST is better in terms of average path, packet send and higher throughput, Centralized mode is good in terms of average jitter, average delay and drop ratio, and dense mode is better in terms of packet delivery Ratio.

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