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Performance of Video Conferencing in Unicast and Multicast Communication using Protocol Independent Multicast Routing

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***Abstract*– With video conferencing becoming extremely popular in wired and wireless network, efficient utilization of the network bandwidth is important to achieve Quality of Service (QOS). Internet Protocol (IP) multicast is a routing technique that allows IP traffic to be sent from one source or multiple sources and delivered to multiple destinations. Instead of sending individual packets to each destination, a single packet is sent to a multicast group, which is identified by a single IP destination group address. In this paper it is proposed to compare the performance of video conferencing using unicast and multicast communication using Protocol Independent Multicasting – Sparse Mode (PIM-SM) modes.**

***Index Terms*– Unicast, Multicast, Protocol Independent Multicast-Sparse Mode and Internet Group Management Protocol**

I. INTRODUCTION

IN unicast transmission a packet that has to be sent to multiple destination nodes end up traversing the same links repeatedly. In broadcast transmission all end nodes in the network would receive the information instead of only the intended recipients. Multicasting is the simultaneous delivery of packets to multiple nodes and has become an essential requirement for multimedia applications [1]. For multicast sessions to be successful, the network must transport data in these sessions using minimal network resources. A multicast session in the network is established by creating a multicast tree along which the data is transferred. The construction of the tree using specific algorithms is called as multicast routing algorithms. Group applications demand a certain amount of reserved resources to satisfy their quality of service (QoS) requirements such as end-to-end delay, delay variation, loss, cost, throughput to name a few [2]. Since resources for multicast tree are reserved along a given path to each destination in a given multicast tree, it may fail to construct a multicast tree to guarantee the required QoS if a single link cannot support required resources. Thus an efficient solution for multicast communications includes the construction of the multicast tree that has the best chance to satisfy the resource requirements [3].

Tree construction for multicast routing algorithms can be broadly classified into:

- Source Based Algorithms(SBA)
- core Based Algorithms(CBA)

SBA algorithms construct a tree from the source and sends messages to each destination in the multicast group. A global state is maintained at every node in the network. SBA is currently being used as the tree construction algorithm for Protocol Independent Mode Dense Mode (PIM-DM) and Multicast Open Shortest Past First (MOSPF).

Core based Algorithms (CBA) is typically used in many to many multicast situations. In this method a core node is selected as the root for the multicast tree that has to be determined. A tree rooted to the core node is built to span all the members in the group. The selection of the core node is important and affects the Quality of Services (QOS) directly. Core Based Tree (CBT) and Protocol Independent Multicast Sparse Mode (PIM-SM) notably use CBA. In this paper it is proposed to evaluate the performance of unicasting and multicasting in a sparse network using Protocol Independent Multicasting Sparse Mode (PIM-SM) under different link scenarios.

II. LITERATURE REVIEW

Constructing a multicast tree with minimal cost is a NP-hard problem and usually implemented using Steiner tree [4], [5]. Kou et al., proposed the Kou, Markowsky and Berman (KMB) algorithm [6] where the network is built as a complete graph such that each node represents either a source or destination with the edge cost being lowest among all paths connecting the two nodes. Prims algorithm [7] is used to find the Minimum Spanning Tree (MST). KMB algorithm however does not address the QOS issues required in today's network scenario.

Kompella et al proposed Kompella, Pasquale and Polyzos (KPP) algorithm [8] keeping in mind the QOS parameters. To achieve QOS, link cost and link delay were taken into consideration with the delay constraint requirement maintained for a specific threshold. The tree construction is based on a near Minimum Cost Tree such that the delay between every two destination nodes is less than the specified threshold.

Bounded Shortest Multicast (BSM) algorithm [9] is based on the Shortest Path Tree (SPT) and tends to find the shortest end to end delay path. BSM initially builds a SPT and refines the SPT recursively by replacing the f branching nodes with lower cost branching nodes. The branching nodes are also called as super edges.

III. PROPOSED METHODOLOGY

The architecture of the test system used for simulation is shown in Fig. 1 and Fig. 2.

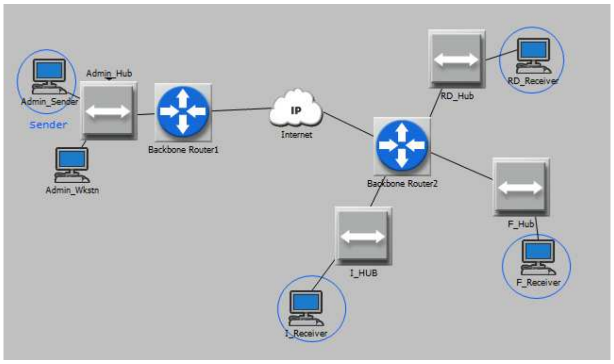

Fig. 1: A single route from source to various destinations.

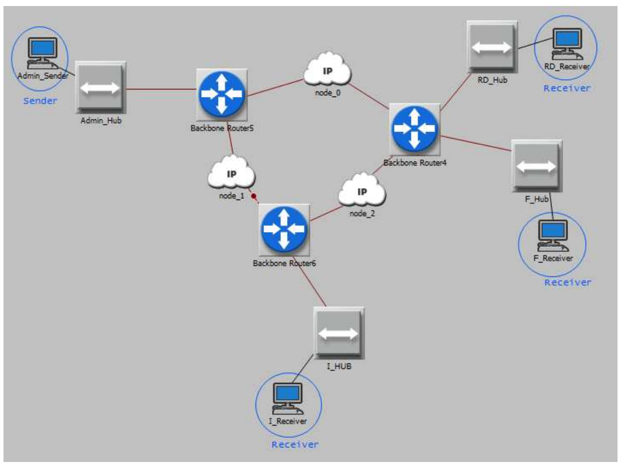

Fig. 2: Simulation set up with multiple routes to destination.

Five network scenarios are considered. In the first scenario, video data is transferred from the sender to three receivers using a single link. In the second scenario the receivers can be reached through multiple routes. In the other scenarios the number of nodes receiving video data is 3, 10, 20 and 30. A sparse group of nodes is made up of group members present in significantly smaller than the number of networks in the internet. Sparse group are also characterized by group members spanning an area that is too large to rely on hop count. The PIM-SM protocol can be broken down into the following parts:

- Neighbor PIM router discovery
- Forwarding multicast packets to the current multicast group
- Joining a multicast group
- Registering with the Rendezvous Path
- Switching to the shortest path tree
- Pruning interfaces
- Route Assert
- Determining the Rendezvous Path

In the first stage 'Hello' messages are multicast to the multicast group address. The router with the highest IP address is elected as the Designated Router (DR). A new DR is elected whenever the old DR times out. In the second stage a set of routers are assigned as Bootstrap Router (BSR). All candidates Rendezvous Point (RP) periodically send Candidate RP Advertisement(C-RP-Advs) messages to BSR. The bootstrap in turn sends bootstrap messages containing candidate RPs. In the third stage join / prunes are sent periodically to all PIM neighbours [10].

IV. RESULT AND DISCUSSION

Opnet was used for the experimental setup. Opnet is a versatile simulation tool to model devices in the network, protocols and architectures. Using Opnet it is possible to simulate the performance of the designed network. Results obtained from the setup are shown in Table I, II and Table III. Fig. 3, Fig. 4 and Fig. 5 represent the data graphically. The end to end delay is calculated as the sum of transmission delay, processing delay and propagation delay.

TABLE I. SENDER BACKBONE QUEUING DELAY IN SECONDS

	Mean delay in seconds	Min delay in seconds	Max delay in seconds	Std dev of delay in seconds
Unicast- 3 receiver	0.000110574	0.00000576	0.00012208	2.26037E-05
Multicast - 3 receiver	0.000112673	0.00000576	0.00012208	2.79309E-05
Multicast- 10 receiver	0.00011263	0.00000576	0.00012208	2.77223E-05
Multicast- 20 receiver	0.000113548	0.00000576	0.00012208	2.52834E-05
Multicast- 30 receiver	0.000113121	0.00000576	0.00012208	2.753E-05

The throughput is computed as the average rate of data transfer over the communication channel. From figure 3 it is seen that even if the number of node is increased the queuing delay does not increase significantly. Similarly the queuing delay idoes not increase significantly as the number of receivers is increased within the same domain.

TABLE II: RECEIVER QUEUING DELAY IN SECONDS

	Mean delay in seconds	Min delay in seconds	Max delay in seconds	Stddev of delay in seconds
Multicast Multipath	0.000102	5.76E-06	0.000104	1.446E-05
Unicast- 3 receiver	0.000101	5.76E-06	0.000104	1.74E-05
Multicast - 3 receiver	9.81E-05	5.76E-06	0.000104	2.203E-05
Multicast- 10 receiver	9.83E-05	5.76E-06	0.000104	2.207E-05
Multicast- 20 receiver	9.83E-05	5.76E-06	0.000104	2.207E-05
Multicast- 30 receiver	9.83E-05	5.76E-06	0.000104	2.194E-05

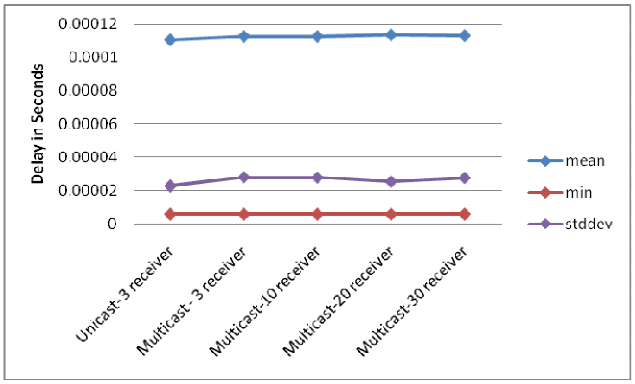

Fig. 3: The queuing delay in seconds at the backbone router as it receives traffic from sender.

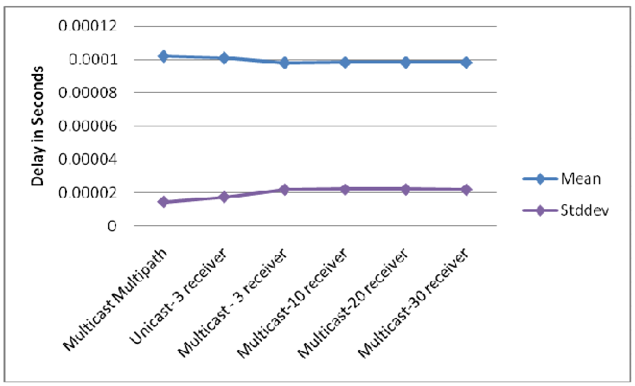

Fig. 4: The queuing delay at receiver hub.

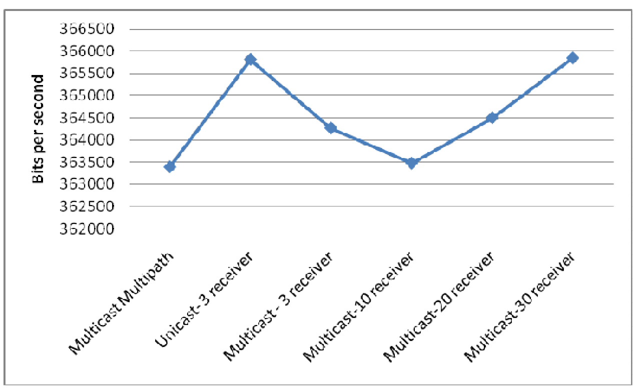

Fig. 5: The mean throughput at receiver F in bits per second

From Fig. 5 it can be seen that the queuing delay due to multicast – multipath scenario decreases significantly. This can affect the quality of video conferencing as receiver nodes which can enjoy multipath receives data faster and hence a uniform delay cannot be maintained as the overall QOS of the video conferencing system may come down.

TABLE III: THROUGHPUT AT RECEIVER F IN BITS PER SECOND

	Mean throughput in bps	Max throughput in bps	Stddev in bps
Multicast Multipath	363396.2	415360	135837.46
Unicast-3 receiver	365809.9	415487.5	134227.57
Multicast - 3 receiver	364270.2	415577.2	135095.95
Multicast-10 receiver	363482.7	415529	135732.71
Multicast-20 receiver	364498.6	415520.3	134941.52
Multicast-30 receiver	365840	415553.1	134195.18

V. CONCLUSION

In this paper it was proposed to compare the performance of data transmission under three scenarios, namely unicasting, multicasting and multipath based multicasting. Under multicasting scenario, the number of nodes receiving the data was varied. It is found that for sparsely populated nodes the delay in receiving the data does not vary significantly. However in multipath multicasting there is a significant lowering of the delay. Work needs to be done to address this as the QOS will be affected if the receivers contain eithermultipath and unipath routes.

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