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A Study on the Effect of Transmission Power Adaptation of QOS/QOE Mechanisms in Heterogeneous Wireless Networks

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ABSTRACT

Applications require a certain amount of distribution of a group of resources to satisfy the quality of service (QoS) requirements of quality, such as an end-to-end latency, jitter and loss, cost and productivity, such as, but not limited to. Due to resource reservation multicast tree along a particular path for each target in a multicast tree, it may not be possible to establish a multicast tree, in order to ensure that the services, if a link cannot support the resources needed, the required quality. With the advent of wireless devices, multicast is to include wired and wireless devices in heterogeneous environments. Multicast field research in a heterogeneous environment highlights the challenges of theater concept, especially in the service and the quality of streaming live video conference. A wireless device may be infrastructure, or infrastructure, resulting in no quality of service, the physical layer because of the inherent quality of integral wireless device. The proposed PIM-HMC compared to improve the delivery rate by 1.85 percent more than allocated on demand distance vector (MAODV) and 13.35% for the next transmitter, the anger of decline. This program is not being played and the link quality of the mobile over the nodes in a heterogeneous network has an important role in the quality of service. Mainly due to the wireless network as the base quality of the performance of mobility and link on the shortest route, the route discovery mechanisms, which is not the best way to ensure the technical quality of service required. Quality of service is the basis of NP-complete problems on the road in the exploration, proposed the use of genetic algorithms to determine, based on the best available technology to adapt the best way to function derived utilization. The proposed technique is displayed in a single sender, raising packet delivery ratio 3.5% compared to, PIM-HMC. Similarly, the improvement is seen as multiple scenes sender.

Keywords: Heterogeneous Multicast Connectivity, Mobile Ad hoc Network, Packet Delivery Ratio, Simplified Multicast Forwarding, Wireless networks

1. INTRODUCTION

Most quality metrics including delay and cost being additive in nature, spanning trees and routing problems solved in the literature are either NP-Hard or NP-Complete problems [1]. The traditional methods used in multicasting cannot solve the QoS problem. Researchers are working extensively in the areas of the heuristic algorithms to provide solutions which improve the QoS. Heuristic algorithms provide near optimal solutions within a polynomial time crucial for the real time networks. The multicast routing problem, and the problem of finding an optimal (shortest) path, it is more complicated than that of unicast. Whereas in unicast the shortest path should be found connecting a source to the destination in order to perform multicast and all nodes belonging to the multicast group must be interconnected by a tree as shown in Figure 1. There are various approaches to construct a multicast tree; the simplest algorithm builds a routing tree by the addition of one participant at a time through a shortest path algorithm.

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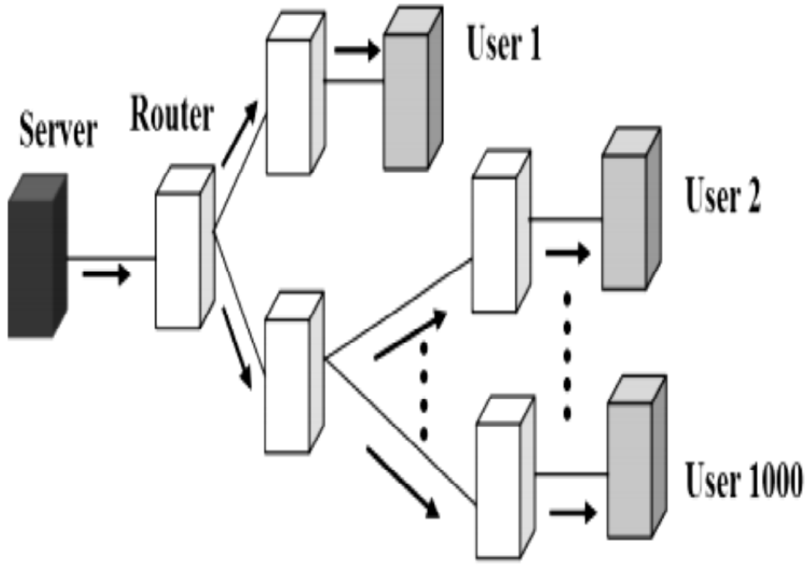

Figure 1: Multicasting to 1000 users

To maintain the Quality of service in the Multicast heterogeneous networks, the literature survey has to focus on Multicast Wired Networks, Wireless Networks and Heterogeneous Networks. Multicast communication that provides many-to-many communications involves a source/set of sources sending data to receivers. Multicasting, an important communication paradigm, models many applications like subscription services (news groups), collaboration/conferencing services etc., Hosts co-operate as a group to achieve tasks in an Ad hoc environment and so MANET model suits a multicast paradigm. Multicast models are ideal for bandwidth constrained networks like MANETs as it improve network use through mass data distribution and hence its importance in Ad hoc networks. In order to receive multicast, a host needs to join the multicast groups it wishes to receive from. This is achieved using the Internet Group Management Protocol (IGMP). If a host only wants to send multicast traffic, there is no need for protocol between host and router. The host simply sends the multicast packets out of the link, and it will be forwarded by a multicast router. The advantages of Multicasting include support of distributed applications to enable the next generation multimedia applications such as distance learning and video conferencing. It also scales when the number of participants rise reducing the load on the sending server [2]. The IP multicast group model is an open service model. There is no mechanism to restrict the hosts or users from creating a multicast group, receiving data from a group, or sending data to a group. The multiple senders may share the same multicast address. Senders cannot reserve addresses nor prevent another sender from choosing the same address. The notion of group membership is only a reachability notion for receivers and is not meant to provide any kind of access control.

2. LITERATURE SURVEY

The literature survey reveals that constant QoS is achievable in wired networks whereas wireless networks suffer from delay and jitter which affects the overall QoS of the network. It is also seen from literature survey that traditional wired network based multicast protocols like Protocol Independent Multicast–Sparse Mode (PIM-SM), Core Based Tree (CBT) do not work well in a MANET due to the frequent tree organization. In this paper, heuristic techniques are investigated to achieve overall QoS [3]. The detailed objectives of this paper are listed as follows. Investigate the performance of multicasting in a heterogeneous network using Protocol Independent Multicasting Sparse Mode (PIM-SM) under different number of senders and receivers. Investigate PIM-SM on wired side of the network and Multicast Ad-hoc On-Demand Distance Vector Routing Protocol (MAODV) on wireless side i.e., MANET side of the heterogeneous network using a gateway for interconnection. Investigate PIM-SM on wired side of the network and Multicast Ad-hoc On-Demand Distance Vector Routing Protocol (MAODV) on wireless side i.e., MANET side of the heterogeneous network using a gateway for interconnection. Propose a Protocol Independent Multicast Quality of Service Improvement in Heterogeneous Network using Genetic Optimization. Multicasting in Heterogeneous environment is emerging as an exciting research area due to the QoS challenges especially in live streaming and video conferencing. This challenge increases multifold with different physical media for data transmission comprising wired and wireless devices. The wireless devices can either be one hop devices connecting to an access point or MANET using multihop routes to reach the wired / wireless gateway or multicast communication between nodes in the wireless media itself. This work critically examines the performance degradation of multicast networks in a heterogeneous environment. The parameters examined include Packet Delivery Ratio (PDR), End to End Delay and Jitter. Based on the conclusion drawn from the initial investigation a novel multicast protocol PIM-HMC is proposed to improve the performance of the wireless side of the heterogeneous network [4]. Since wireless networks are mainly affected by mobility and link quality, the route discovery mechanism techniques based on shortest path does not guarantee as the optimal route for required QoS. Route discovery based on QoS being an NP Complete problem, it is proposed to use optimization technique using Genetic Algorithm for identifying ideal routes based on the derived fitness function [5]. The recent past saw the Internet evolving from wired infrastructure to a hybrid of wired/wireless domains ensuring microwave access (WiMAX), Wi-Fi, and cellular networks interoperability globally ensuring an increasing need to facilitate reliable content delivery over heterogeneous networks. But, Application Layer Multicast (ALM) is a promising approach to stream media content from a server to many interested nodes. ALM nodes construct a multicast tree through which they deliver the data stream

3. PROPOSED WORK

Second-generation mobile communication services have expanded explosively globally from the late 1980's. Many wireless communication systems like IEEE 802.11a/b wireless LAN, Bluetooth, IMT-2000, and Fixed Wireless Access (FWA) systems today provide easy internet access for improved communication

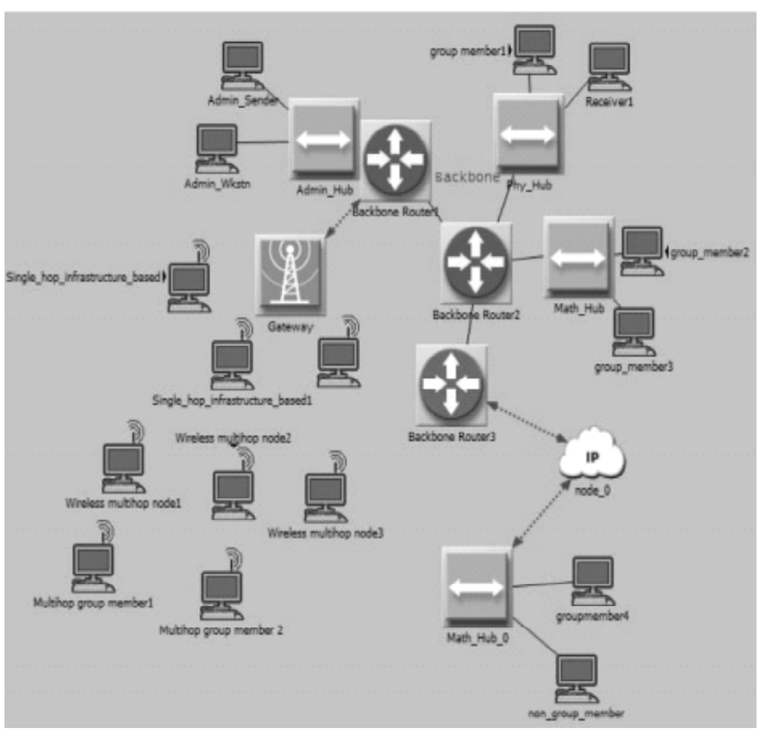

Figure 2: Heterogeneous Networks Architecture of this Work

[6]. There are many digital communication systems independently designed, implemented, and operated to meet mobility, data rates and services mobility. Some provide services at specific locations thereby creating a heterogeneous wireless environment in overlaid service areas. Seamless heterogeneous wireless systems integration is expected to use in a wireless communications industry revolution affecting vendors, service/application/context providers, policy makers, and users [7]. An integrated heterogeneous environment enables users access specific networks based on applications and types of radio access networks (RANs) available (cellular network, WLAN, wireless personal area network (WPAN)). For example, in a scenario where a user downloads a large video file through multimode phone cellular interface, availability of higher-data rate and lower-cost connection through home IEEE 802.11b ensures that the connection automatically switches over from cellular network to home AP. Automatic connection and seamless network migration for a single call can be anticipated in the future.

Figure 2 shows a heterogeneous network consisting of wired nodes communicating via router and to the wireless side using gateway. The wireless nodes are either one hop nodes or multi hop to reach the gateway. The end to end delay in the wireless side is higher than the wired side.

4. MOBILE AD HOC NETWORK

Wireless networks were first used in DARPA radio packet networks. Improvement in mobile computing and wireless communications initiated more research in wireless computing [8]. Ad Hoc Networks (MANETs) lack infrastructures and are autonomous networks with wireless mobile computing devices. MANETs are peer-to-peer networks where all network nodes have similar abilities to communicate without needing intervention or a centralized access point/base-station. Mobile nodes/devices include wireless transmitters and receivers with omni directional antennas resulting in a broadcast medium [9]. They can also be highly directional ending in a point-to-point network. Wireless interfaces limited transmission range ensures that these networks are multi-hop networks with a node having to relay messages to a destination through intermediate nodes. So, in a MANET all nodes are both routers and host. Due to the mobility of the nodes, the topology of the MANETs is highly dynamic. A MANET can be viewed as a dynamic multi-hop graph. When compared to wired networks, MANETs have lower channel capacity due to wireless links, combined with effects of interference and noise, the effective bandwidth available for communication is reduced [10]. The mobile devices are mostly run on batteries, thus the networks are also energy constrained.

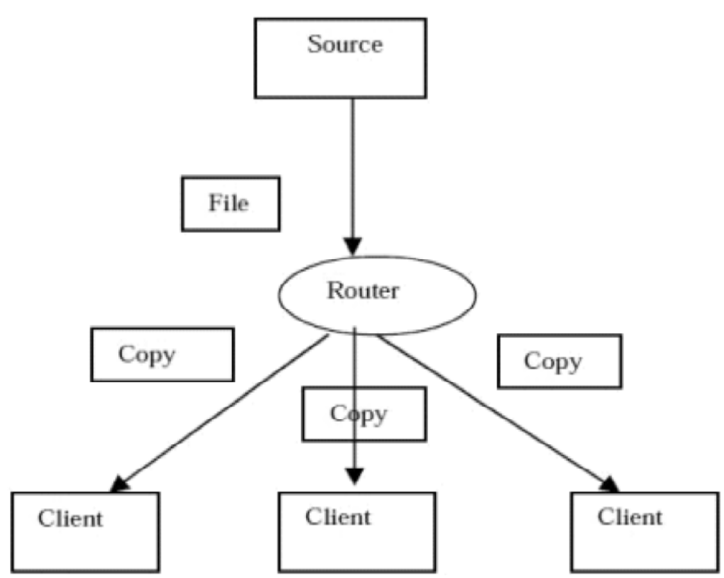

Figure 3: Basic Multicast Network

IP networks originally introduced Multicast. Many applications, for example, Internet gaming, IP teleconferencing, and Internet television need data to be sent from one or several senders to several receivers. Multicast applications involve multipoint communication/multicast whereby data is delivered from one or several sender nodes to several designated nodes. The 2 types of addresses on the Internet are unicast and multicast [11]. Normally on the internet a host/node has only one unicast address and it can be a member in multiple multicast groups. Multicast communication helps multimedia application deployment. When paths to many destinations overlap only one data packet copy is sent over a network link on that path. Packets in the router are duplicated when paths diverge, and they are then sent to appropriate links. Multicast usage benefits are twofold. Multicast reduces server load as it sends only one packet per link, as against multiple packets to varied receivers. It also reduces overall network load, since only one data packet copy is transmitted thereby reducing overall bandwidth consumption greatly. 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 QoS requirements such as end-to-end delay, delay variation, loss, and cost.

5. GENETIC ALGORITHM (GA)

The Gradient search techniques are intended for local search, obtaining solutions around the region of its starting point. Global search techniques obtain more optimal solution, though it is dependent on an ideal set of starting values. The Genetic Algorithm (GA) is a population-based optimization algorithm, built on the basis of biological evolution. The Gene sets are replicated, varied and mutated during the process of natural evolution. Similarly, mechanisms such as selection, reproduction, mutation are used in GA to evolve better solutions [12]. The solutions to the optimization problem represented in bit-strings are the population used in GA. Fitness functions are used to evaluate each solution. The initial population is evolved through to the next generation on application of operators such as selection, reproduction, crossover and mutation. Better solutions are produced during each generation. The evolution process continues forming new generations till an appropriate solution is reached or a specific number of generations have been obtained. The pseudo algorithm of GA is shown,

BEGIN

1. Generation t = 0;
2. Initialize the population P(t);
3. While not Termination criterion do
   (a) Evaluate the population P(t);
   (b) Next P'(t) (by crossover/mutation) over P(t);
   (c) Evaluate P'(t);
   (d) P(t+1) = select from P'(t);
   (e) Generation t=t+1;
4. End while.

For n_i ε N_r a routing table is built. It consists of the *R* shortest, *R* cheapest and *R* least used paths. *R* is a parameter of the algorithm. A chromosome is represented by a string of length |*Nr*| in which each element (gene) g_i represents a path between source s and destination d. A route is selected based on the following parameter. The Fitness is computed for each individual, using the fitness function:

$$F(t)=\sqrt{\frac{2J_m}{\lambda_n}}\, e^{-\frac{\lambda_n^2}{2\lambda_n}J_m} \int \frac{\sqrt{\frac{J_m}{2\lambda_n}}\left(\lambda_g+\frac{\lambda_n t}{J_m}\right)}{\sqrt{\frac{J_m}{2\lambda_n}\lambda_g}} e^{-j^2} ds \tag{1}$$

Where,

J_m = max_Jitter

λ_{in} = input package

λ_g = Generated package in node

$\lambda_{out} = \lambda_{in} + \lambda_g$

In this work a two-point crossover operator over selected pair of individuals is implemented with each chromosome of the new population being randomly changed (mutated), obtaining a new solution. The process continues until a stop criterion or the given maximum number of generations, is satisfied.

6. METHODOLOGY

In the proposed method, a multicast routing request m will be accepted if the routing algorithm can find a routed directed tree for *m* with find a routed directed tree for *m* with the minimum cost, while the following three conditions are realized:

(i) Available bandwidth constraint

(ii) Bound jitter constraint

(iii)End to End delay constraint

In this work a two-point crossover operator over selected pair of individuals is implemented with each chromosome of the new population being randomly changed (mutated), obtaining a new solution [13]. The process continues until a stop criterion or the given maximum number of generations, is satisfied. This work is compared with the performance of data transmission for multicasting on the basis of PDR, end to end delay and jitter. Simulation were carried out with equal number of wired and wireless nodes along with different node mobility. Experiments were conducted with different number of senders.To evaluate the performance of the multicasting in a heterogeneous network using Protocol Independent Multicasting Sparse Mode (PIM-SM) under different link scenarios is proposed in this chapter. The network contains both wired and wireless nodes. The Wireless nodes are one hop away from the Access point of the infrastructure based network. It is seen that performance of real time streaming is not affected by nodes using wireless network in the last mile. The PIM-SM forwarding uses RPF check on the incoming interface to trace looping packets. The unicast routing information is derived from the unicast routing tables, independent of the unicast routing protocol that constructed them. PIM-SM uses “semi-soft” states - the state information in each on-tree router has to be periodically refreshed (by sending join/prune message for each active entry in the PIM routing table) [14]. The periodic messages can reflect changes in topology, state or membership information. If the periodic update message is not received from a downstream router within the pre-set timeout period, the state entry is deleted from the upstream router’s local memory. Since the state information is periodically refreshed, PIM-SM does not need an explicit tear down mechanism to remove state when a group ceases to exist.The number of networks/domains with members is smaller than the total number of networks/domains in a region. Group members are widely distributed.

7. EXPERIMENTAL RESULTS

The network is a heterogeneous network made of MANET and wired network connected via gateway. Two sets of protocols are investigated for this heterogeneous network. The overhead of flooding all the networks with data followed by pruning networks with no members in them is significantly high. Proposed PIM-HMC (Heterogeneous Multicast Connectivity) on the wireless side. HMC is derived from Simplified Multicast Forwarding (SMF) [15]. Optimized PIM-GAHMC using GA techniques to improve the QOS for heterogeneous environments consisting of wired and wireless nodes. OPNET was used for the experimental setup. Simulations are conducted using a similar setup as used in the previous chapter with a combination of both wired and wireless nodes. 50% of the wireless nodes are mobile and are investigated for 10 kmph and 30 kmph mobility speed. Theperformance of the heterogeneous network is studied in terms of Packet Delivery Ratio (PDR), End to End delay and Jitter. Experiments were carried out to compare the performance of data transmission for multicasting on the basis of PDR, end to end delay and jitter.

Table 1
Performance of the Heterogeneous Network with no Mobility of Wireless Nodes

Method	*Number of Senders*	*Avg PDR*	*Avg. End to End delay in second*	*Avg. Jitter in second*
HMC	1	0.9172	0.0387	0.000734
	5	0.9065	0.0587	0.000822
	10	0.9012	0.0594	0.000968
	20	0.8942	0.0602	0.001023
	30	0.8733	0.0632	0.001654

It is observed that the optimized method of route discovery increases the average PDR by 4.06%. As multicasting spans through the wired and wireless devices in heterogeneous networks, resources along the path may fail to guarantee the required QoS leading to failure of the multicast tree [16]. For efficient multicast communication, it is required that the tree constructed satisfies the resource requirements. The goal of QoS is to provide a certain level of predictability and control on the service. Delay, Jitter, Bandwidth and Reliability are commonly used parameters that measure the QoS. PIM-HMC is optimized with genetic algorithm to improve the performance. Multicast routing route which realizes the available bandwidth constraint, bound jitter constraint and end to end delay constraint is found [17]. Simulation results show that the PIM GAHMC performs better than PIM-HMC with regard to the packet delivery ratio. It was also observed that the end to end delay for the video conferencing is same; Quality of service is improved by reducing the jitter.

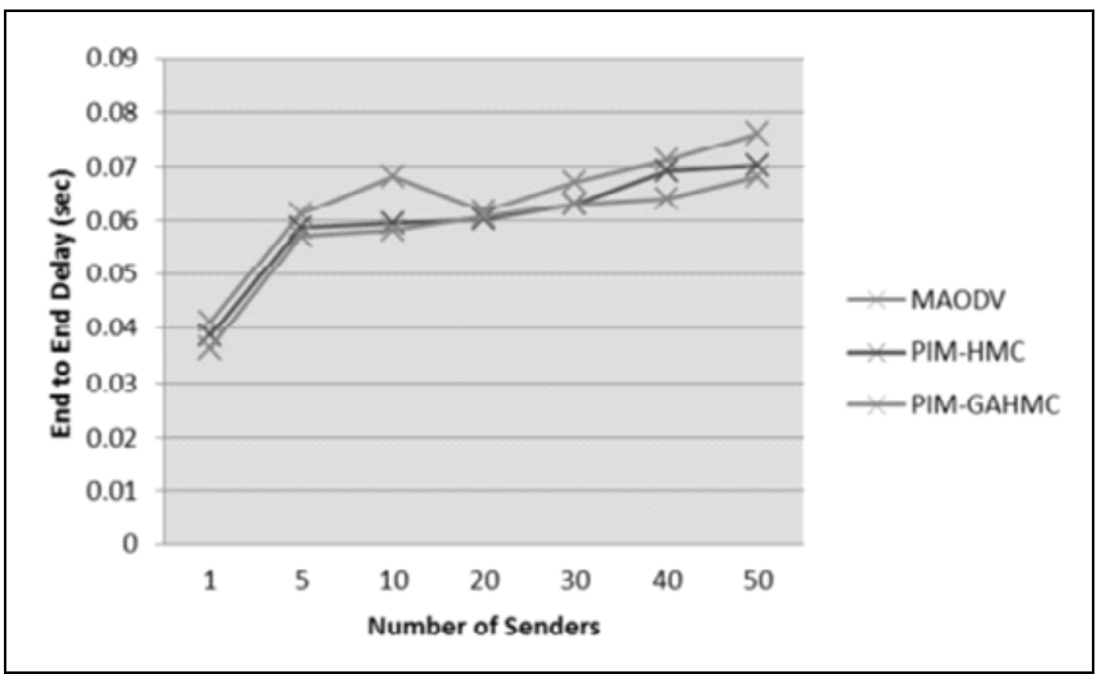

Figure 5: End to End Delay

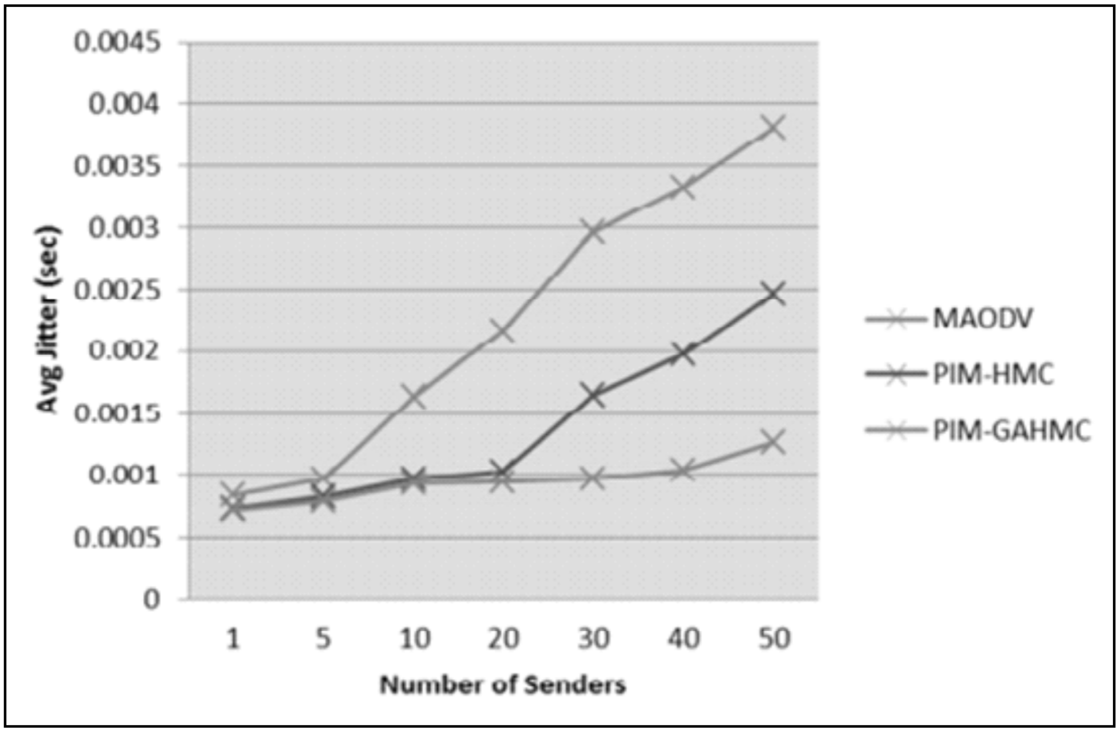

Figure 6: Jitter when all group Members without Mobility

It can be seen that end to end delay and jitter decreases using the optimization technique [18]. The fitness function is able to identify routes such that the overall end to end delay is reduced even at high mobility for a large number of senders and thus overcoming the problems faced in PIM-HMC. It is observed from the tables and figures that the heterogeneous network performs better with PIM-GAHMC than PIM-HMC when the mobility is less [19]. PDR improves considerably with PIM-GAHMC. It can be seen that the end to end delay for the video conferencing is same, Quality of service is improved by reducing the jitter.

8. DISCUSSION AND CONCLUSION

Multicasting in a heterogeneous network using Protocol Independent Multicasting Sparse Mode (PIM-SM) was implemented and evaluated under different number of senders and receivers are studied. All the experiments were conducted using OPNET simulation tool. Network contains both wired and wireless nodes. The Wireless nodes are one hop away from the Access point of the infrastructure based network. Simulations are conducted using varying number of senders and are varied from 1, 5, 10, 20, 30, 40 and 50 senders. Number of receivers is 30 to 60 nodes and consists of a combination of both wired and wireless nodes. The performance of the heterogeneous network is studied in terms of Packet Delivery Ratio (PDR), End to End delay and Jitter.Multicasting in a heterogeneous network using Protocol Independent Multicasting Sparse Mode (PIM-SM) was implemented and evaluated under different number of senders and receivers are studied. All the experiments were conducted using OPNET simulation tool. Network contains both wired and wireless nodes. The Wireless nodes are one hop away from the Access point of the infrastructure based network. Simulations are conducted using varying number of senders and are varied from 1, 5, 10, 20, 30, 40 and 50 senders. Number of receivers is 30 to 60 nodes and consists of a combination of both wired and wireless nodes. The performance of the heterogeneous network is studied in terms of Packet Delivery Ratio (PDR), End to End delay and Jitter.It was observed that the optimization of the routing with respect to bandwidth, jitter and end to end delay, improves the QoS of the network considerably.

9. FUTURE WORKS

Future investigations can be conducted on the working of a reliable MAC layer that scales with the number of nodes.Though, link constraints (e.g., bandwidth) and path constraints were considered in this research, further investigation on improving the probability of the successful joining, minimizing the joining time and cost of joining can be investigated.Investigate the performance of the proposed PIM-GAHMC with larger networks.

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