Use of IEEE 802.11e to Ensure the Quality of Service (QOS) For Multimedia Streaming

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ABSTRACT: *Multimedia streaming is a key service provided by certain home appliances. A home network helps to control home appliances, to connect the internet and to use data in home server. A large bandwidth and real time operations are required for multimedia streaming services that consist of large amount of data and require sufficient bandwidth and delay variation to achieve the good quality of service. It is difficult for WLAN to guarantee a high QOS with respect to bandwidth and delay. Hence 802.11e standard is designed to solve this problem. It has Hybrid Coordination Function (HCF) and Enhanced Distributed Coordination Function (EDCF) to support QOS that could not be supported in the 802.11 standard. The Hop-Based Priority (HBP) technique using 802.11e is used for ensuring a good QOS for multimedia streaming. In HBP technique, the multimedia streaming data packets are assigned a higher priority after every hop. So that each packet increases the priority and minimizes the contention between the packets. We propose HBP technique in Adhoc mesh network. The wireless mesh network has been an emerging technology, since many routes may randomly exist and some routes have a lower priority than other routes at cross route node and cannot obtain the channel. For this, label switching routing protocol is used for the efficient transmission to reduce the delay and improve the throughput.*

Keywords: *Multimedia streaming, 802.11e EDCF, Hop-based priority technique, label switching routing protocol.*

I. INTRODUCTION

Networks have evolved from wired to wireless. Recently, users of wireless LAN (WLAN) like laptop computer, PDA, mobile internet devices are increasing rapidly. WLAN supports scalability, flexibility and ubiquity, and these features make WLAN more popular. Especially, wireless multi-hop network has overcome the limit of WLAN's communication range. The applications and services of wired and wireless networks are not different. Quality of Service (QoS) is a key problem of today's IP networks.

In wireless environments, bandwidth is scarce and channel conditions are time-varying and sometimes highly lossy. Although IEEE 802.11 Wireless LAN (WLAN) is the most widely used WLAN standard today, it cannot provide QoS support for the increasing number of multimedia applications. Since multimedia streaming services have to be played in real-time, a large bandwidth is required. Services that need a good Quality of Service (QoS) like Voice over IP (VoIP) and multimedia streaming can be provided through wireless networks . However, WLAN cannot provide good QoS with respect to bandwidth and delay. High collision rate and frequent retransmissions cause unpredictable delays and jitter, which degrade the quality of real-time voice and video transmission. So IEEE 802.11e is the MAC enhancement standard used for providing QoS for the real-time applications. In this paper we analyze the Hop-Based Priority technique in multicast network and propose a solution for it.

II. IEEE 802.11E OVERVIEW

The upcoming IEEE 802.11e wireless LAN standard is the MAC enhancement standard for providing QoS capabilities in the emerging wireless local area networks. For achieving QoS, IEEE 802.11e uses multiple queues for the prioritized and separate handling of different traffic categories (TCs).IEEE 802.11e introduces the Enhanced Distributed Coordination Function (EDCF) and the Hybrid Coordination Function (HCF).

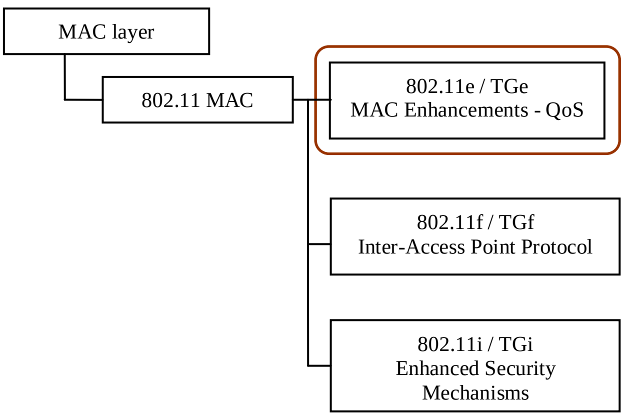

Figure 1 802.11 MAC

The 802.11e MAC is based on both center controlled channel access and contention-based channel access mechanisms. Figure 1 specifies the legacy 802.11 MAC with MAC enhancement scheme for supporting QoS. The 802.11e enhances the Distributed Coordination Function (DCF) and Point Coordination Function (PCF) both the

2.1. Hybrid Coordination Function (HCF)

HCF is the queue based service which extends the Point Coordination Function (PCF) to support the immediate sending of data. An Access Point (AP)-based infrastructure mode is used in HCF. HCF uses QoS-Enhanced Access Point (QAP) as a traffic director for different queues. HCF uses two modes of operation: HCF Controlled Channel Access (HCCA) is contention free, Enhanced Distributed Channel Access (EDCA) is contention based access mechanism.The HCF is the basis for the EDCF and controls both the contention free period (CFP) and contention period (CP). Therefore one enhanced station must be responsible for the management of the medium access. His station is denoted as Hybrid Coordinator (HC). The HC is normally co-located to the access point (AP).

III. Enhanced Distributed Coordination Function (EDCF)

EDCF supports priority upon DCF. EDCF introduces the concept of traffic categories. EDCF provides differentiated, distributed channel accesses for frames with eight different priorities (from 0 to 7) by enhancing DCF as specified in Table 1.

Table 1 User traffic priorities mapped to access categories

User Priority	**Access Category**	**IEEE 802.11E Service Type**
1	AC_BK	Background
2	AC_BK	Background
0	AC_BE	Best Effort
3	AC_BE	Video
4	AC_VI	Video
5	AC_ VI	Video
6	AC_VO	Voice
7	AC_VO	Voice

EDCF establishes a probabilistic priority mechanism to allocate bandwidth based on traffic categories. Distinct from the legacy DCF, the EDCF is not a separate coordination function rather, it is a part of HCF of 802.11e MAC. Each frame from the higher layer arrives at the MAC along with the specific priority value. Then, each QoS data frame carries its specific priority value in the MAC header frame. 802.11e station implements four access categories where an access category is an enhanced variant of DCF 0.

The EDCF enhances the 802.11 DCF by introducing an own backoff instance with a separate backoff parameter set for each priority queue. Each TC on a station contends for a transmission opportunity (TXOP). A TXOP is defined as *"an interval of time when a station has the right to initiate transmissions, defined by a starting time and the maximum duration"*.

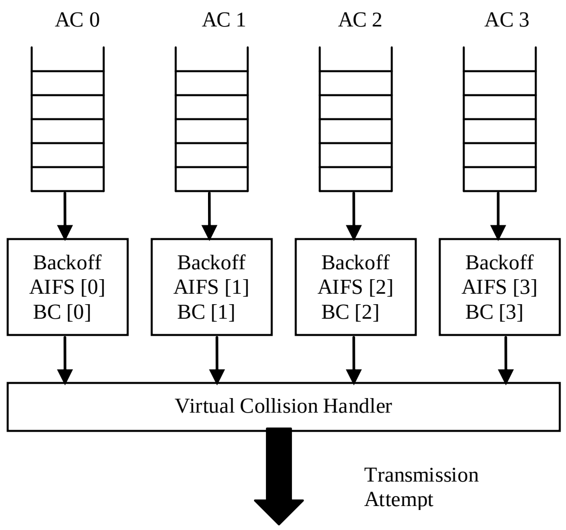

Figure 2 Four access categories for EDCF

Figure 2 shows the four transmission queues of 802.11e MAC, where each queue has its own AIFS and maintains its own backoff counter [12]. Each queue contends for Transmission Opportunity (TXOP) to send the packets. When more than one access categories compete for the backoff at the same time then collision is handled virtually. It means, the highest priority frame among the colliding frames is transmitted and the other frames perform a backoff.

An access category uses AIFSD [AC], CWmin [AC] and CWmax [AC] instead of DIFS, CWmin and CWmax of DCF respectively for the contention process to transmit the frame. AIFSD [AC] is given by,

AIFSD [AC] = SIFS + AIFS [AC] * SlotTime

Where AIFS [AC] is an integer greater than 0. The EDCF channel access mechanism is shown in Figure 3.

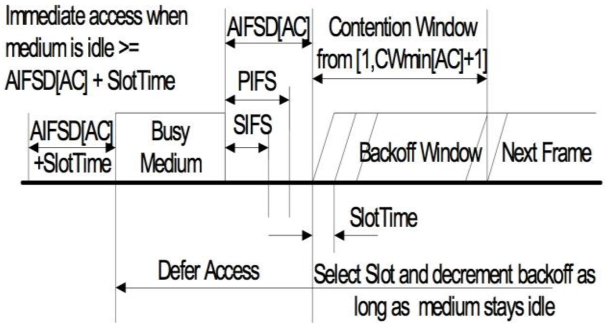

Figure 3 IEEE 802.11e EDCF channel access

EDCF => Enhanced Distributed Channel Access (EDCA).

IV. HOP-BASED PRIORITY TECHNIQUE

The Hop-Based Priority (HBP) technique using 802.11e EDCF is used for minimizing the contention between the hops. A previous packet contends with a next packet when packets try to transmit to a destination through a route. If the previous packet and next packet have the same priority and contend with each other by a fair condition which means the probability of gain of each packet in the channel is 50%. The effect that the next packet cannot get the channel by contention with the previous packet is small. If the next packet wins the previous packet and transmits one more hop, it cannot transmit more hops until the previous packet transmits. This causes the delay to decrease and bandwidth to increase. So the previous packet has a highest priority than the next packet every time.

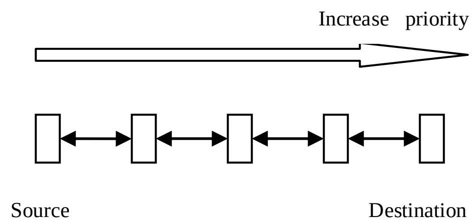

Figure 4 Hop-by-hop increases in priority

In order to avoid this contention between the previous and next packets Hop-based priority technique is used. In HBP, each packet increases the priority after every hop and minimizes the contention between the packets as specified in Figure 5. In other words, a priority is assigned to each hop and a packet is assigned a higher priority after each hop. The inter-packet delay is constant in HBP. The HBP technique uses 802.11e EDCF which can control the channel gain on the basis of priority.

V. RELATED WORK

Most of the previous work on wireless LAN specifies the QoS using various mechanisms.

In [2], A. Ksentini et al. introduced a new cross-layer architecture that ensures H.264 video transmission over IEEE 802.11-based wireless networks. This architecture achieves better performances in terms of delays and loss rate than actual WLAN standard and QoS enhancement mechanism and increases the video quality.

In [3], Q.Zhang et al. proposed a new multimedia streaming TCP-friendly protocol (MSTFP) and a novel quality-adaptation resource allocation scheme to periodically estimate the available bandwidth using MSTFP. It achieves the improvement in end-to-end QoS.

In [4], H. Gharavi et al. proposed a cross-layer feedback mechanism with a rate control approach. This method effectively controls the packet-loss rate by avoiding excessive packet drops, which could affect the resynchronization process at the decoder.

In [5], Antonio Grilo et al. presented a scheduling algorithm- Scheduling Based on Estimated Transmission Times—Earliest Due Date (SETT—EDD)for QoS provisioning in IEEE 802.11e WLANs. SETT-EDD achieves better performance in the transmission of streamed video.

VI. PRIOR WORK

The main objective of this paper is to improve the Quality of Service(QoS) for multimedia streaming services in IEEE 802.11e standard using Hop Based Priority(HBP) technique.The Hop Based Priority(HBP) technique is used in IEEE 802.11E Standard.IEEE 802.11 Wireless LAN(WLAN) is one of the most deployed wireless technologies in all over the world and is likely to play a major role in next generation wireless communication networks.The IEEE 802.11 wireless LAN has simple and robust WLAN which offers time-bounded and asynchronous services.

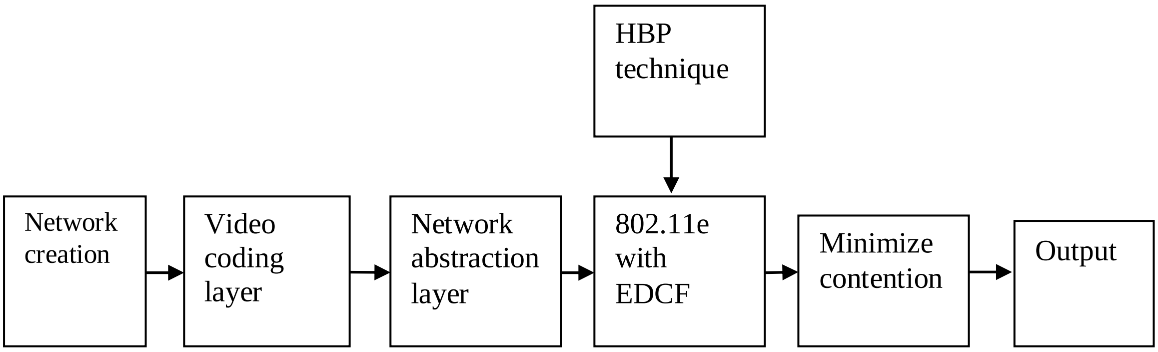

Figure 5 Block diagram of HBP with mesh network

5.1 Wireless network creation

The network topology in an ad-hoc network is highly dynamic due to the movement of nodes; hence an on-going session suffers frequent path breaks. Disruption occurs, either due to the movement of intermediate nodes in the path or due to the movement of end nodes. Such situations do not arise because of reliable links in wired networks where all the nodes are stationary. Even though wired network provides high reliability with low cost but the Quality of Service (QoS) is not provided in the better way. So the wireless ad-hoc networks must be used able to perform efficient and effective mobility management. The simulation time required to create wireless network is 15M. The following two parameters stand for the physical terrain in which the nodes are being simulated. For example, the following represents an area of size 100 meters by 100 meters. All range parameters are in terms of meters.

TERRAIN – DIMENSIONS (800,800)

The following parameter represents the number of nodes being simulated.

NUMBER-OF-NODES 10

5.2 Video coding packet

Requirements of multimedia streaming are different from those of a general file transfer. Bandwidth is the most important factor in a file transfer. A large bandwidth leads to a short transfer time and guarantees a good QoS. However, streaming has variable requirements with respect to the type of streaming service. Bandwidth is important in multimedia streaming. Multimedia data size typically ranges from a few megabytes to a few gigabytes. These large amounts of data require sufficient bandwidth to minimize buffering. If sufficient bandwidth is not guaranteed, then multimedia streaming service must have periodic buffering or download all multimedia data before play. Therefore, bandwidth is an important factor for multimedia streaming. Another important requirement for multimedia streaming is the delay variation or jitter. Buffering for multimedia streaming is decided by the delay variation. When the delay variation is large, the buffering time increases considerably in order to minimize the effect of delay. Delay is determined upon the initialization of multimedia streaming. If a delay spike occurs after initialization, additional buffering is required and a low quality of multimedia is experienced. In ad-hoc network, Ad-hoc On-demand Distance Vector (AODV) protocol maintains a routing table for an entry (destination) with a hop count (number of hops from source to destination) and a sequence number. This can be used by the application to control the transmission rate in accordance with the hop count. If a route change is the consequence of a link breakage, any intermediate node (between the source and the destination) detecting the link breakage (to the next hop) will send the route error (RERR) message back to the source node. Therefore, the source node may use the reception of RERR as an indication of a link breakage. As soon as a new route is established, the application layer, upon receiving the hop-count information from the routing layer, can adjust its bit rates in accordance with the permissible transmission rate. In the case of video communications, the bit rates can be adjusted by changing the value of the Quantization Parameter (QP). This parameter has been specifically defined in the syntax structure by all video coding standards as a means to control the video transmission rate. Here, a new video-coding standard such as H.264 Advanced Video Coding (AVC) is used. H.264 AVC is a standard capable of proving good video quality at substantially lower bit rates than previous standards (H.263 or MPEG-4), without increasing the complexity of design so much that it would be impractical or excessively expensive to implement. An additional goal was to provide enough flexibility to allow the standards to be applied to a wide variety of applications on a wide variety of networks and systems, including low and high bit rates, low and high resolution video, broadcast and ITU-T multimedia telephony systems.

5.3 Network abstraction layer

Cross-layer architecture is designed for H.264 AVC. Such a cross-layer architecture is based on two main interactions with 802.11e. First, a top-down cross-layer interaction allows the H.264 network abstraction layer (NAL) video delivery module to transmit the QoS information related to the video fragment priority to the network layer. Second, a second top-down cross-layer interaction allows the network layer, in turn, to express the same QoS exigencies to an EDCA-BASED MAC layer.

5.4 Hop-based priority

Multimedia streaming services require sufficient bandwidth and delay variation to achieve the good Quality of Service (QoS). Previous ad-hoc networks could not satisfy these requirements since 802.11 requires an ad-hoc wireless network with 802.11 to have a contention between the previous and next hops. This leads to delay fluctuation and additional back-off time due to collision. These, in turn, decrease the network bandwidth. The Hop-based priority (HBP) technique using 802.11e is used for minimizing the contention between hops. A previous packet contends with a next packet or a later sent packet when the packets try to transmit to a destination through a route. The previous packet and the next packet have the same priority and contend with each other by a fair condition. It brings the probability of the gain of each packet in the channel to 50%. The effect that the next packet cannot get the channel by contention with the previous packet is small. If the next packet wins the previous packet and transmits one more hop, it cannot transmit more hops until the previous packet transmits. In other words, winning of the previous packet from the next packet causes the delay to decrease and the bandwidth to increase. Therefore, the previous packet has a higher priority than the next packet every time. Hence, HBP technique is used to avoid the contention between the previous and the next packets. In other techniques, every packet has a fixed priority, and the previous packet and the next packet contend with each other. In HBP, each packet increases the priority after every hop and minimizes the contention between the packets.

5.5 Comparison

The performance of the proposed Hop-based priority technique using 802.11e is measured by the throughput and delay. The throughput comparison is made based on the delay variation between various IEEE 802.11 standard with 802.11e standard. First the analysis of delay in 802.11 WLAN is made. The delay in 1-hop transmission is denoted as

$$T_{trans} = T_{bas} + T_{cont} + T_{col} \quad (3.1)$$

T_{trans} denotes the time of 1-hop transmission. T_{bas} is the basic transmission time. T_{cont} and T_{col} are the additional delay caused by the loosening from contention and collision. T_{bas} is the total sum of the DCF interframe space (T_{difs}), random backoff (T_{ran}), transmission data (T_{data}), short interframe space (T_{sifs}) and transmission acknowledgement (T_{ack}) time.

$$T_{bas} = T_{difs} + T_{ran} + T_{data} + T_{sifs} + T_{ack} \quad (3.2)$$

T_{ran} is based on the size of the contention windows (CWs) and can be calculated.

$$T_{ran} = (CWmax + CWmin)*slot\_time/2 \quad (3.3)$$

T_{const} has a probability related to the loosening for contention (P_{loose})

$$T_{const} = P_{loose} * (T_{difs} + T_{data} + T_{sifs} + T_{ack}) \quad (3.4)$$

When a collision occurs, 802.11 operates the random backoff and attempts to transmit the data.
The total delay can be calculated by T_{tran} * (number of hops). In 802.11e with HBP, the total delay has to be calculated because the priority changes at every hop.

VII. PROPOSED WORK

In the previous work, HBP technique is used in wireless multi-hop networks to avoid the contention between the packets. 802.11e EDCF supports eight priorities, which implies that HBP technique has a limit of eight hops. We propose a Wireless Mesh Networks (WMN) using HBP technique which has a number of features that distinguish from wireless multi-hop networks. First, the positions of nodes of a WMN are relatively fixed it means any change of position is limited within certain range. The implication of this is that routing paths can be created that are likely to be stable. This reduces the need for routing packet overhead. Second, unlike pure ad-hoc networks, where the traffic flows between arbitrary pairs of nodes, in WMN, all traffic is either to or from a designated gateway, which connects the wireless mesh network to the Internet. The relevance of this point is that the traffic may be split over multiple gateways, so as to reduce the load within any given portion of the network. Third, the nodes will typically have access to a power source, and so power consumption is not a critical issue.
Packet delay is caused by various reasons, including collision resolution during packet forwarding, packet buffering, and different scheduling algorithms [13]. However, the most critical cause is packet delay in WMN is path length. Under the same traffic intensity, a smaller number of hops would lead to less packet delay. For two nodes, S (x_S, y_S) and D (x_D, y_D), in a grid network, their shortest distance is given in equation,

$$d = | x_S – x_D | + | y_S – y_D | \quad \ldots\ldots\ldots\ldots(1)$$

To minimize the packet delay, the shortest path is used. However, this must be done in the context of minimizing collisions, since highly-contended paths that are shortest are not necessarily ideal. In Label switching protocol (LSP) each packet is associated with labels. Each packet is associated with the labels. It reduces the complexity of network operation.LSP always select the shortest path. Label switching protocol is used in MPLS (Multiprotocol label switching).

5.1 Wireless mesh network

Wireless mesh networks have the potential to play a critical role as an alternative technology for last-mile broadband internet access.The positions of different nodes of a WMN are relatively fixed.It can be viewed as a special case of wireless multihop Adhoc networks, in which each node operates both as a host and as a router.
Wireless mesh networks are as with pure Adhoc networks easy to install.The setup cost for internet service providers is only gateway installation and configuration.
The most commonly used topology for wireless mesh network is a grid layout of buildings.Since each node would communicate with the gateway.In that mesh network label switching protocol is used to find the shortest path.

5.2 Label switching protocol

In Label switching protocol(LSP) each packet is associated with labels.Each packet is associated with the labels.It reduces the complexity of network operation.LSP always select the shortest path.Label switching protocol is used in MPLS(Multiprotocol label switching).

The label switching protocol(LSP) is used in the Multi protocol label switching(MPLS).It provides a foundation that supports the deployment of advanced routing services because it solves a number of complex problems:

- It addresses the scalability issues associated with the currently deployed IP over ATM overlay model.
- It reduces the complexity of the network operation.
- It facilitates the delivery of new routing capabilities that enhance conventional IP routing techniques.
- It also offers a standards based solution that promotes multivendor interoperability.

VIII. RESULTS AND IMPLEMENTATION

To validate our analysis, we have to implement the Hop-Based Priority (HBP) technique in 802.11e for wireless mesh network (WMN) in a simulator and by performing a series of simulation based experiments to test its effectiveness. Glomosim simulator is used for the simulation purpose and the simulation parameters are,

Simulation parameters

Simulation time	15M
Number of nodes	25
Node placement	Grid
MAC protocol	802.11
Routing protocol	AODV

We have compared the throughput of 802.11 alone the data sending rate from 800 Kbps to 1500 Kbps range. With these we are going to add HBP technique and compare the results with the current 802.11e, same as we have compared the delay of 802.11 with adding HBP technique and compare the results with current 802.11e.Then the delay and throughput comparison is made. Under the consideration for the transmission of multimedia data, the Hop-Based Priority (HBP) technique has to be implemented in 802.11e.

Table 2 Comparision table forThroughput values

DATA SENDING RATE	IEEE 802.11 VALUES	IEEE 802.11E VALUES	IEEE 802.11E WITH MESH NETWORK
800	950	950	960
900	1089	972	1102
1000	1198	1024	1223
1100	1238	1031	1298
1200	1342	1045	1395
1300	1457	1052	1564
1400	1476	1064	1599
1500	1498	1071	1612

Table 3 Comparision table for Delay values

DATA SENDING RATE	IEEE 802.11 VALUES	IEEE 802.11E VALUES	IEEE 802.11E WITH MESH NETWORK
800	0	0	0
900	0.05	0.001	0.003

1000	0.07	0.02	0.016
1100	0.04	0.018	0.03
1200	0.035	0.015	0.03
1300	0.032	0.014	0.03
1400	0.039	0.014	0.029
1500	0.034	0.015	0.0275

7.1 Simulation Results

In the first module the creation of the nodes is done. The simulation time required to create wireless environment is 15M. The following two parameters (800,800) required to stand for the physical terrain in which the nodes are being simulated. The numbers of nodes being simulated are 10. The packets are transmitted from the source node (5,7) to the destination (1,3) respectively in which normal transmission of packets takes place. Since the video packet is also considered as the ordinary data packet, the transmission of the video packet takes more time which increases the delay so the throughput decreases.

7.1.1. Screenshots

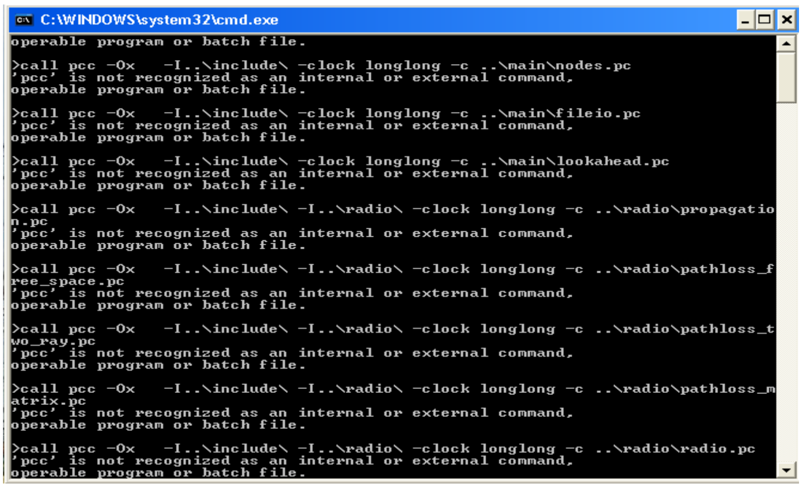

Figure 7.1.1 Compilation steps

Figure 7.1.1 shows compilation for all layers like physical layer,data link layer,network layer,radio layer.

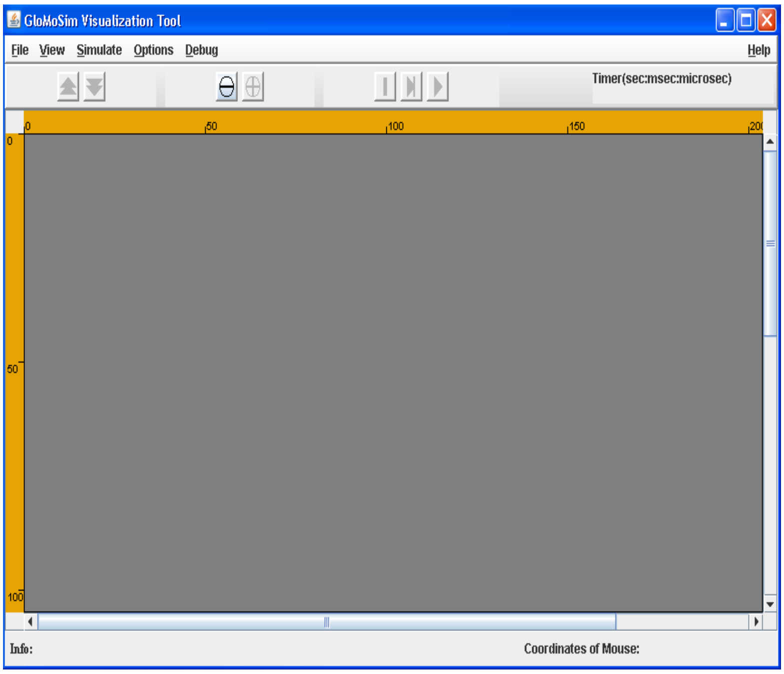

Figure 7.1.2 Glomosim Visualization

Figure 7.1.2 shows the glomosim visualization tool. Global Mobile Information System Simulator (GloMoSim) is a scalable simulation environment for large wireless and wire line communication networks. GloMoSim uses a parallel discrete-event simulation capability provided by Parsec. GloMoSim simulates networks with up to thousand nodes linked by a heterogeneous communications capability that includes multicast, asymmetric communications using direct satellite broadcasts, multi-hop wireless communications using ad-hoc networking, and traditional Internet protocols.

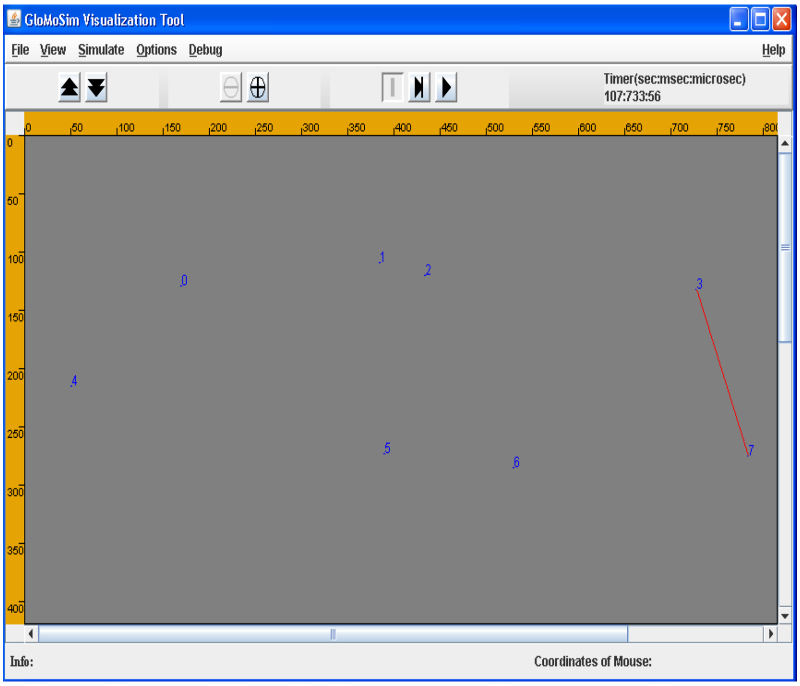

Figure 7.1.3 Transmission of Packets

Figure 7.1.3 shows the transmission of packets.Here the packets are transmitted from the source node (5,7) to the destination (1,3) respectively in which normal transmission of packets takes place.

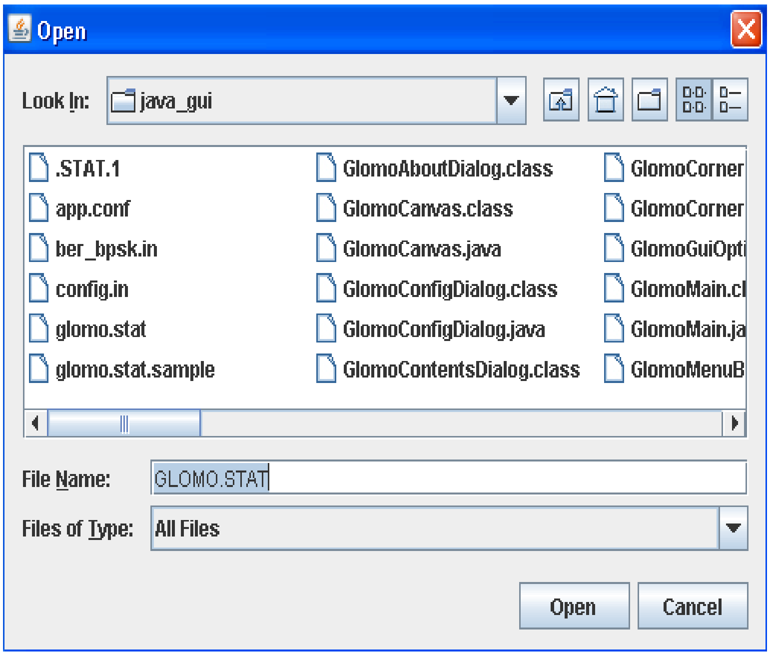

Figure 7.1.4 Glomo.stat file view

Figure 7.1.4 shows the GLOMO.STAT file is produced at the end of the simulation and contains all the statistics generated.

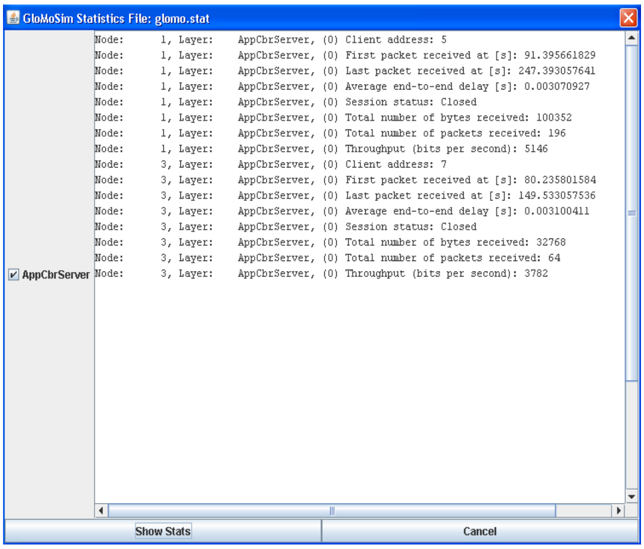

Figure 7.1.5 Viewing the stat file in visualization tool

Figure 7.1.5 shows the stat file in visualization tool for viewing the throughput and delay values of each packets.

IX. Output of throughput and delay

Comparing the throughput and delay values of 802.11(WLAN), 802.11e with HBP, HBP with mesh network. Here the HBP with mesh network throughput is high compare to the other throughputs.But the HBP with mesh network delay is constant(low) compare to the others delays.

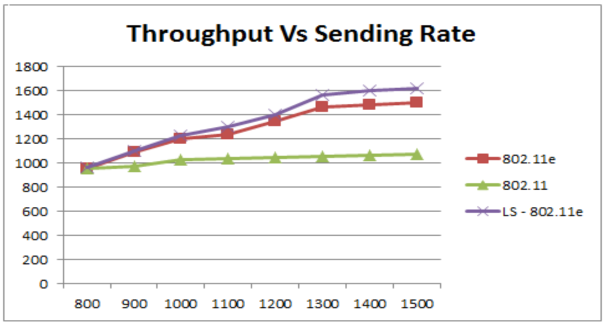

Figure 6 Throughput comparision

Figure 6 shows the throughput waveform of wireless network,x-axis shows the data sending rate in kilo bits per second(kbps),y-axis shows the throughput values IEEE 802.11,IEEE 802.11E with HBP technique and IEEE 802.11E with HBP mesh network,in kilo bits per second(kbps).

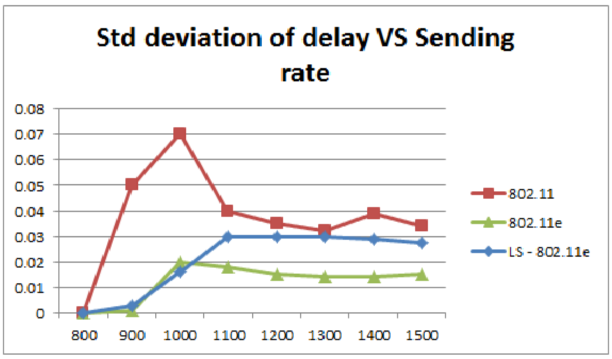

Figure 7 Delay comparision

Figure 7 shows the throughput waveform of wireless network,x-axis shows the data sending rate in kilo bits per second(kbps),y-axis shows the delay values of IEEE 802.11,IEEE 802.11E with HBP technique andIEEE 802.11E with HBP mesh network,in seconds(sec).

VIII. CONCLUSION

The usage of multimedia streaming in the wireless network is an open problem and deserves more research work. In this paper, we have analyzed the usage of multimedia streaming data packets in 802.11e using wireless mesh networks and presented the objectives that need to be achieved. Here we have shown that it is easy for the transmission of multimedia packets using hop-based priority technique in adhoc mesh networks so that the contention between the transmissions of packets is reduced with the improvement in the throughput. Which in turn increases the channel usage for the various other data transmission for the improvement in the Quality of Service (QoS). Since security is the main challenging issue, that has to be implemented in future.

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