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Two Level Implementation of Multicasting in Wireless Networks with Multirate Scheme

T. Srikanth[1], Dr. K. Venkata Rao[2]

M.Tech Student, Computer Science and System Engineering, Andhra University, Visakhapatnam, India [1]

Associate Professor, Computer Science and System Engineering, Andhra University, Visakhapatnam, India [2]

Abstract: Multicasting is one of the best solutions for sending data to a particular group of users. It became so prominent because it reduces the bandwidth of data that is intended to transfer than compared to unicast transmission. In multicast transmission data rate in WLAN is limited by the user with lowest receiving data rate in multicast group, which was named as constant base rate problem. We propose a delivery method that utilizes both multicasting and unicasting to solve the constant base rate problem with multirate technique. Multicasting is used between IPV4 server to Access Point (AP) and unicasting is used between AP and mobile nodes. AP converts the multicast packets to unicast packets in order to provide end-to-end multicast transmission. By combing both multicasting and unicasting we are able to solve the problem of constant base rate problem. But if more number of users under an AP wants to receive many streams of multicast type then the congestion is occurred in the wireless network under AP. In the proposed method, the AP switches to multirate mode to solve the congestion problem because the bandwidth utilized by the multirate technique at AP is very less when compared to the existing method.

Keywords: Multicast, Unicast, Constant base rate and Quality of Experience.

I. INTRODUCTION

In order to send a specified data to a group of members using of unicast communications is not an effective solution as it uses a significant amount of bandwidth. So, this problem is solved by the multicasting as it provides best-effort delivery of data and messages from a sender to multiple receiver [4,5]. Multicasting has a wide range of applications such as video-conferencing, distance learning, school e-learning lectures and location based military programs.

Coverage area and transmission rate are usually used to determine the quality of multicast service over Wireless Local Area Network (WLAN). But, there is a trade-off between coverage and transmission. More the coverage area decreases the transmission rate of the AP. And in multicasting to make all the members to receive data at different locations the data rate is fixed to a constant value. AP will reduce the transmission rate for all the members of the group whenever a member of the group moves to the boundary as well as when a member of a group experiences a low data rate transmission in order to prevent high packet loss [7,8] and this phenomenon is called constant base rate problem. The solution for this problem must also guarantee Quality of Service (QoS) and Quality of Experience (QoE).

There are various solutions that tried to mitigate the constant base rate problem and are categorized into multirate support [9, 10], rate-controlled [11–15], auto rate selection [16–19], and rate optimization [20, 21]. In case of multirate support schemes, multiple channels are used by the network servers for handling data transmissions at many different rates. And to transmit data to a group of users, some schemes of this type make use of cross-layered multicast, and then use multiple rates.

In case of rate controlled multicast schemes, the rate of data transmission is controlled by server. These approaches while performing bulk data transfer, when some members of the group successful finish of data reception, the rate of transmission is changed by the server to the highest possible rate. These approaches achieves the optimal rate of transmission by optimizing the rate control. While in auto rate selection approaches, the appropriate data rate is selected on the basis of the channel conditions [16-19]. The server increases the data rate when the channel is in good condition. In rate optimization approach the transmission data rate is optimized by combining Medium Access Control (MAC) layer multicast policy with erasure coding of transport layer. The cross layer approach embedded in rate optimization schemes ensures multicast optimal transmission rate. And because of the nodes mobility, there are frequent changes in data rate transmission and all these existing systems suffer from high packet loss, complexity communication, and computation costs.

II. RELATED WORK

If In IEEE 802.11 standard, the data rate of transmission is decided by depending on the distance between the mobile user and AP in order to achieve the high throughput and less packet loss. In any IEEE 802.11 standard, the mobile user who is closer to the AP receive higher data rate than user who is farther away from the user. That means farther the mobile user lesser the data rate the mobile user experiences. The Fig. 1 depicts this scenario.

In unicasting the users experience different data rates based on the distance between AP and the mobile user. In multicasting the group members receive the data at same

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rate. Consider a scenario of IEEE 108.11g with three mobile users connected to an AP as shown in the figure Fig.1. If the AP transmits the data at 54 Mbps, the user who is closer to the AP will be able to receive the data where the other 2 users cannot able to receive data at 54 Mbps speed. In order to make all the users to receive the data, the AP transmits data at lowest data rate (i.e., 1 Mbps). But, use of this lowest data rate decreases the throughput, as it not allow the nearest users to receive the data at higher rate. There are some research efforts have been made to address this issue and are categorized into rate-controlled, rate adaption, multirate support and rate optimization.

The rate-controlled approach, the server changes the rate of transmission to achieve best *QoS. Du and Zhag* [11] proposed a rate-controlled method for real time data transmission. Whereas *Bhatacharya et al.* [12] proposed a method for bulk data transfer. But these approaches suffer from unfair transmission. In rate adaption and selection approaches, based on the condition of the member channel the auto tare section approaches are proposed aiming to adapt and select the multicast rate of transmission. This approach requires prior knowledge and continuous checking of the channel.

In the category of rate optimization, an approach [20] determines the optimal value for base rate transmission. While some other author's proposed cross-layered approach. This approach is based on erasure coding in transport layer and rate optimization in MAC layer. This approach considers a predefined threshold T. The packets are transmitted at least T receivers are ready and the lost packets are recovered by redundant packets.

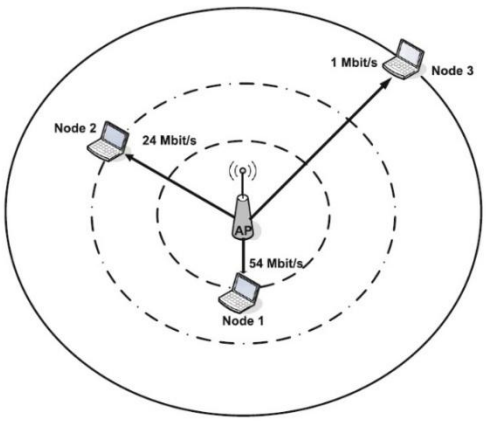

Fig. 1 Coverage Area vs. Data Rate

In multirate support approach, the transmission of data by the server is done at different rates, and the number of data rates to be used can be defined statically of dynamically. The data transmission in this approach looks similar to conventional multicast, but it solves the problem of fixed base rate problem. In the scenario described in Fig, 1, there is no need for the AP to reduce its data rate to the lowest value i.e., 1Mbps. This approach allows the AP to transmit data at two different data rates say 54 and 1 Mbps. The nearest node to AP i.e., node 1 receives the data at both rates and node 2 and node 3 receives data at the rate of 1 Mbps, whereas node 2 can be able to receive data at higher rate than 1 Mbps.

In summary, due to channel estimation and information gathering from members of a group, the above approaches suffer from complexity, costly implementation and security vulnerabilities and our proposed method is capable of working in dual mode of transmission (multicast and multicast and unicast). But the above mentioned methods can only be implemented in multicast of the AP.

III.PROPOSED METHOD

The method we propose is driven by the idea of achieving highest possible data rate value, by increasing the date rate of each member of a group which in turn increases throughput. QoE can further increased by reducing jitter, delay and packet loss. To achieve these ideal performances the AP must convert the multicast packets into uncast packets and by doing so we also achieve end-to-end multicasting. At the time of retransmission, use of this technique has more benefits. In existing systems, adjustment of data rate and selection of the appropriate data rate when users move around in a dynamic network environment is difficult.

The figure 2 depicts how the mobile users join and leave a group in the proposed method. The user sends the join request to the AP whenever the user wants to become a member of a multicast group. The AP learns about the MAC address of the user by reading the join request and checks the availability of the multicast group and then the request is forwarded to the server and waits for the acknowledgment from the server in order to update its routing table which can be used to map the MAC address of the user to the particular multicast group. Similarly when a user is intended to leave a multicast group the user sends the leave request to the AP and the access point simply deletes the entry in the routing table that matches up with the user's MAC address and the Multicast group ID.

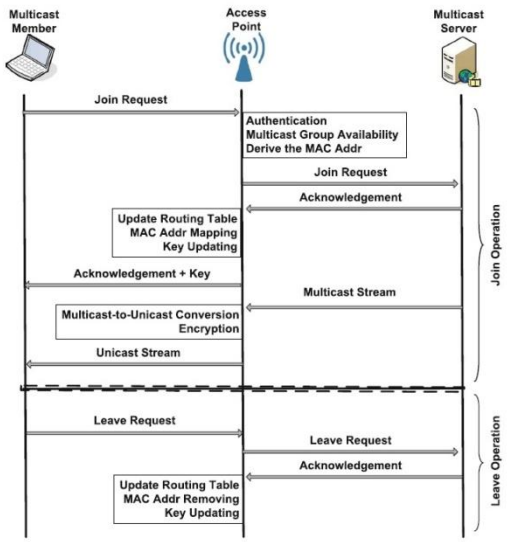

Fig. 2 Sequence Diagram for Join & Leave operations at AP

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Every member of a group is incorporated with the possible highest data rate r_m which belongs to as set of data rates r_s. The set r_s varies depending upon the standard we use. And r_f be the fixed data rate of the members of multicast groups which are near to AP.

The value of r_f is less than r_m which depicts that the member can receive higher data rate in the group. And by using unicasting instead of multicasting every member can receive highest possible data rate i.e., r_m which is associated with the mobile user. And the value of r_m differs for members of a group depending upon the distance between the member and AP. And which in turn will not affect the other member of a group when a member of a group is moving towards the boarder of coverage area.

When more number of users under the AP wants to receive streams of multicast type, the congestion problem is occurred in the wireless network under the AP. This problem is occurred because of converting the multicast packets to unicast packets.

To solve this problem, the AP switches to multirate mode to reduce the bandwidth utilization in the wireless network under AP.

The AP operates in two modes those are multicast-unicast mode and multirate mode. Mulicast-unicast mode is applied at AP under normal circumstances where as multirate mode is applied to when more number of users under the AP becomes members of multiple multicast groups. Because of multirate method utilizes less bandwidth when compared with multicast-unicast mode, it is better to use multirate method when there is a chance of congestion in the wireless network.

IV. PERFORMANCE EVALUATION

For evaluating the performance of our method we compare our method with conventional multicast by considering QOE and bandwidth as a metrics.

The QOE performance of the proposed method will be checked with respect to real time data handling.

By comparing the video quality of Uc and Um in the existing method and proposed method.

Fig. 3 QOE in Existing Method for Closed-by User

Fig. 4 QOE in Proposed Method for Closed-by User

Fig. 5 QOE in Existing Method for Mobile User

Fig. 6 QOE in Proposed Method for Mobile User

The bandwidth usage of the multirate method at AP is less when compared to the multicast-unicast method as shown in the following fig.

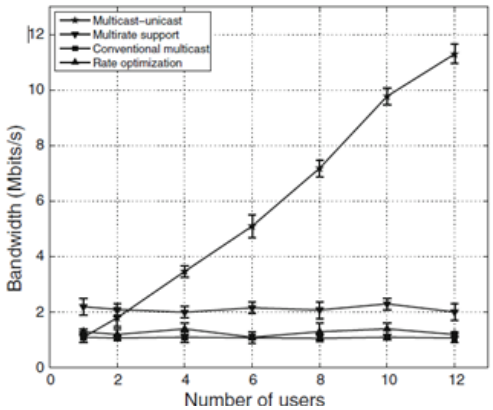

Fig. 7 Bandwidth utilization at AP

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V. CONCLUSION

In this paper, the problem in wireless LANs during multicast transmission is focused. More number of members of multicast group are facing low throughput and QOS due to constant base rate problem in wireless LANs. One member who receives data at less rate can affect all the other members of the group as their data rates also get reduced. To solve this problem we propose a method for multicasting over wireless LANs. The multicasting is performed in two levels: multicast level and unicast level. Multicast level is from server to AP and unicast level is from AP to member of the group. Conversion from multicast packets to unicast packets is done by AP. By doing this, the QOE of the members those are able to receive data at high rates are increased and the packet loss is decreased. By combing both multicasting and unicasting we are able to solve the problem of constant base rate problem. But if more number of users under an AP wants to receive many streams of multicast type then the congestion is occurred in the wireless network under AP.

In the proposed method, the AP switches to multirate mode to solve the congestion problem because the bandwidth utilized by the multirate technique at AP is very less when compared to the existing method.

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