Effective Video Streaming with Low Latency over MANET

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Abstract: In this paper we address the challenge of delivering a video stream with low latency in MANET. The major challenges while streaming video over MANETs are latency, control overhead. Latency and control overhead can be reduced by using Enhanced Efficient Geographic Multicast Protocol (EEGMP). The EEGMP uses a virtual-zone-based structure to implement scalable and efficient group membership management for video packets. The position information guides the zone structure building, multicast tree construction, and packet forwarding, which efficiently minimizes the overhead for route searching and tree structure maintenance. Compared to Efficient Geographic Multicast Protocol (EGMP), EEGMP has significantly lower control overhead and latency.

Keywords: MANET, video streaming, multicast, latency.

I.INTRODUCTION

A Mobile ad hoc network (MANET) is an infrastructure less, self configuring, self-organizing and self-administering wireless network. Video streaming means transferring continuous stream of video packets in a particular interval. Video streaming addresses the problem of transferring video data as a continuous stream. The challenge of delivering real-time video streams in infrastructure less wireless networks, such as a MANET, can be efficiently addressed by Scalable Video Coding (SVC) or multiple description coding (MDC).

Scalable Video Coding guarantees graceful degradation in bit rate and format and provides video services with lower temporal or spatial resolution by transmitting or decoding partial bit streams. The amount of video data delivered by MDC-based systems is higher than SVC. MDC has been proposed as an alternative to SVC. In contrast to SVC, MDC is a form of data partitioning, which fragments single video stream into multiple independent descriptions. In MDC, the video signal is encoded in independent streams, termed as descriptions. Each description can be decoded independently from the others, and each further description improves the quality of the reconstructed signal. When all descriptions are available, the highest quality is attained.

Packet transmission from a source to a destination can be done by routing protocols. There are three types of routing protocols namely, unicast, broadcast and multicast. Unicast routing protocols in which information is sent from only one sender to only one receiver. It saves power, increase the reliability. The major drawback is only one user can access. Broadcast routing protocols in which information is sent from one sender to all the recipients connected to the network. The usage of bandwidth reduces packet loss. The major drawback is delay and overhead. Multicast routing protocols in which more than one sender sent information meant to set of receivers. Multicast saves bandwidth compared to broadcast. Limited bandwidth is used and delay can be reduced. Multicasting plays a vital role in mobile ad hoc networks. Multicasting is more beneficial than multiple unicast in a bandwidth-constrained ad hoc networks. Also it involves in less host and router processing. MANETs is deploying at minimal cost when compared to the other types of network. This provides on the wing information to its users.

As for the problem of streaming multimedia content in MANETs, the literature provides a fair number of solutions. Studies on routing protocol showed that multicast protocols have a reduced delay and a better scalability compared to unicast and broadcast protocols. Multicasting is a type of group communication in which group membership management is a crucial task. The multicast routing protocols categorized into two types: tree-based protocols and mesh-based protocols. Tree based and mesh based protocols are more effective, but their performance degrades in more dynamic networks, which prevents interesting applications such as battlefield awareness services, out-of-office client briefing, or live delivery of special features at music or sport events. To overcome the limits of these protocols in MANETs, we moved towards a hybrid multicast routing protocol which combines the advantages of both tree and mesh based approaches.

The major challenges while transmitting video over MANETs are latency and control overhead. Latency and control overhead can be reduced by using Enhanced Efficient Geographic Multicast Protocol (EEGMP). The EEGMP uses a virtual-zone-based structure to implement scalable and efficient group membership management. The position information is used to guide the zone structure building, multicast tree construction, and multicast packet forwarding, which efficiently reduces the overhead for route searching and tree structure maintenance.

II.EGMP

The EGMP protocol that ensures the delivery of data from the source to the multicast receivers even in the presence of Byzantine attackers.

A) Protocol Overview

EGMP supports scalable and reliable membership management and multicast forwarding through a *virtual zone-based* structure. In a predetermined virtual origin, the nodes in the network selforganize themselves into a set of zones and a leader is elected in a zone to manage the membership of local group. The leader serves as a representative for its zone to join or leave a multicast group as required. As a result, a network-wide zone-based multicast tree is built. The zone-based tree is shared for all the multicast sources of a group. To further reduce the forwarding overhead and delay, EGMP supports bidirectional packet forwarding along the tree structure. That is, instead of sending the packets to the root of the tree first, a source forwards the multicast packets directly along the tree. The multicast packets will flow along the multicast tree both upstream to the root zone and downstream to the leaf zones of the tree. When an ontree zone leader receives the packets, it will send them to the group members in its local zone.

In EGMP, the construction of zone structure is independent with the shape of the network region, and it is very simple to establish and preserve a zone. The zone is used in EGMP to provide location reference and support lower level group membership management. A multicast group can cross multiple zones. With the introduction of virtual zone, EGMP only needs to track the membership change of zones. There is no need to track individual node movement, which significantly reduces the management overhead and increases the robustness of the proposed multicast protocol. For efficient management of states in a zone, with minimum overhead a leader is elected. As a node use periodic BEACON broadcast to distribute its position to facilitate leader election and reduce overhead, EGMP simply inserts a flag in the BEACON message, which indicate whether the sender is a zone

leader. The broadcast message received by all nodes. To reduce the beaconing overhead, instead of using fixed interval beaconing, the beaconing interval for the underneath unicast protocol will be adaptive. A nonleader node will send a beacon, when it moves to a new zone or every period of *Intvalmax*. A zone leader has to send out a beacon every period of *Intvalmin* to announce its leadership role.

A node neighbor table is constructed without extra signaling. When receiving a beacon from a neighbor, a node records the *flag,* node ID and position contained in the message in its neighbor table. A zone leader is elected through the nodes collaboration and maintained consistently in a zone. When a node appears in the network, it sends out a beacon announcing its existence. Then it waits for an *Intvalmax* period for the beacons from other nodes. Every *Intvalmin* a node will check its neighbor table and determine its zone leader under different cases:

1) If there is only one of the nodes in the zone has its flag set then that node set is the leader.

2) If there is more than one node in the same zone have their flags set then the node with the highest node ID is elected as leader.

3) The flags of all the nodes in the same zone are unset then the node which is closer to the zone center will announce its leadership role through a beacon message with the leader flag set.

B) Multicast Packet Delivery

In this section, we explain how the multicast packets are forwarded to the members.

(i) Packet sending from the source

After multicast tree is constructed, all sources of the group could send packets to the tree and the packets will be forwarded along the tree. In most treebased multicast protocols, a data source needs to send the packets initially to the root of the tree. The sending of packets to the root would introduce extra delay especially when a source is far away from the root. Instead, EGMP assumes a bi-directional tree-based forwarding strategy, with which the multicast packets can flow not only from an upstream node/zone down to its downstream nodes/zones, but also from a downstream node/zone up to its upstream node/zone.

A source node is also a member of the multicast group and will join the multicast tree. When a source S has data to send and it is not a leader, it checks the *isAcked* flag in its membership table to find out if it is on the tree. If it is, i.e., its zone has joined the multicast tree, it sends the multicast packets to its leader. When the leader of an ontree zone receives multicast packets, it forwards the packets to its upstream zone and all its downstream nodes and zones except the incoming one.

When a source node S is not on the multicast tree, for example, when it moves to a new zone, the *isAcked* flag will remain unset until it finishes the rejoining to G through the leader of the new zone. To reduce the impact of the joining delay, S will send packets directly to the root zone until it finishes the joining process.

(ii) Multicast data forwarding

In this protocol, only LDR maintain the multicast table, and the member zones normally cannot be reached within one hop from the source. When a node N has a multicast packet to forward to a list of destinations ($D1;D2;D3; : : :$), it decides the next hop node towards each destination (for a zone, its center is used) using the geographic forwarding strategy. After deciding the next hop nodes, N inserts the list of next hop nodes and the destinations associated with each next hop node in the packet header. Then N broadcasts the packet *promiscuously* (for reliability and efficiency).

Upon receiving the packet, a neighbor node will keep the packet if it is one of the next hop nodes or destinations, and drop the packet otherwise. When the node is associated with some downstream destinations, it will continue forwarding packets similarly as done by node N.

From the survey, EGMP protocol is efficient for data packet but for video packets topology maintenance leads to wastage of energy due to routing table information. The multicast tree construction, multicast packet forwarding cause overhead. Due to overhead and energy consumption, latency increased. The challenges while streaming video over MANETs are latency, control overhead, energy consumption.

III. EEGMP Algorithm

Step 1: Network is divided into square zone and in each zone a leader is elected. Zone leader (zLdr) maintains a multicast table.

Step 2: When a zone leader receives the NEW SESSION message, it will record the group ID and the root-zone ID in its multicast table.

Step 3: The leader will send JOIN REQ message towards root zone, on receiving it destination will sent back JOIN REPLY message back to source.

Step 4: The leader will send a JOIN REQ message to the zone to refresh cluster information.

Step 5: Multipath selection is done in the cluster using Dijikstras algorithm.

Step 6: Video is split and transmitted in the selected multipath to multiple selected destinations.

Step 7: When a zone leader receives END SESSION message, the node will remove all the information and stops the transmission.

IV.VIDEO STREAMING TRAFFIC

A video streaming flow can be split into multiple sub-streams and delivered through different network simultaneously. Based on video transmitted, each video traffic burst is generated over fixed intervals and consist of an I or P frame and number of B frame.

To remove temporal redundancy, intra-coded (I) frame are interleaved with predicted (P) frames and bi-directionally code (B) frames. I frames are compressed versions of raw frames independent of other frames, whereas P frames only refer preceding I/P frames and B frames can refer both preceding and succeeding frames. A sequence of video frames from I frame to next I frame comprises group of picture (GoP). Because P and B frames are encoded with reference to preceding and/or succeeding I/P frames, traffic transmission follows the batch arrival.

Multipath Video Multicasting

An ad hoc network is a collection of wireless mobile hosts dynamically forming a temporary network. Quality of Service (QoS) is a set of service requirements that needs to be met by the network while transporting an information stream from a source to its destination. QoS support for Mobile Ad hoc Networks (MANETs) is a challenging task due to the dynamic topology and limited resource. MANETs should provide multiple QoS metrics for real time applications with low delay requirements, especially in multicast situations. Due to the mobility of wireless nodes, the topology of ad hoc networks may change frequently. Thus, the established connection routes between senders and receivers are likely to be broken during video transmission. It causes interruptions, freezes, or jerkiness in the received video signal. An end-to end connection route in wireless ad hoc networks generally consists of multiple wireless links, resulting in higher random packet loss than single hop wireless connections in wireless networks with infrastructure, such as base stations.

Multicast over wireless networks is an important and challenging goal, but several issues must be addressed before many group applications can be deployed on a large scale. Multicasting is a more efficient method of supporting group communication than unicasting or broadcasting, as it allows transmission and routing of packets to multiple destinations using fewer network resources. The existing method deals with 100 nodes in the network with the packet size of 2000Bytes. The video signal is splitted into five parts and transmitted via different paths.

The multicast mode is useful if a group of clients require a common set of data at the same time, or when the clients are able to receive and store (cache) common data until needed. Where there is a common need for the same data required by a group of clients, multicast transmission may provide significant bandwidth savings. On the other hand, since all nodes in an ad-hoc network can be connected dynamically in an arbitrary manner, it is usually possible to establish more than one path between a source and a destination. When this property of ad-hoc is used in the routing process, then multipath routing is invoked in network.

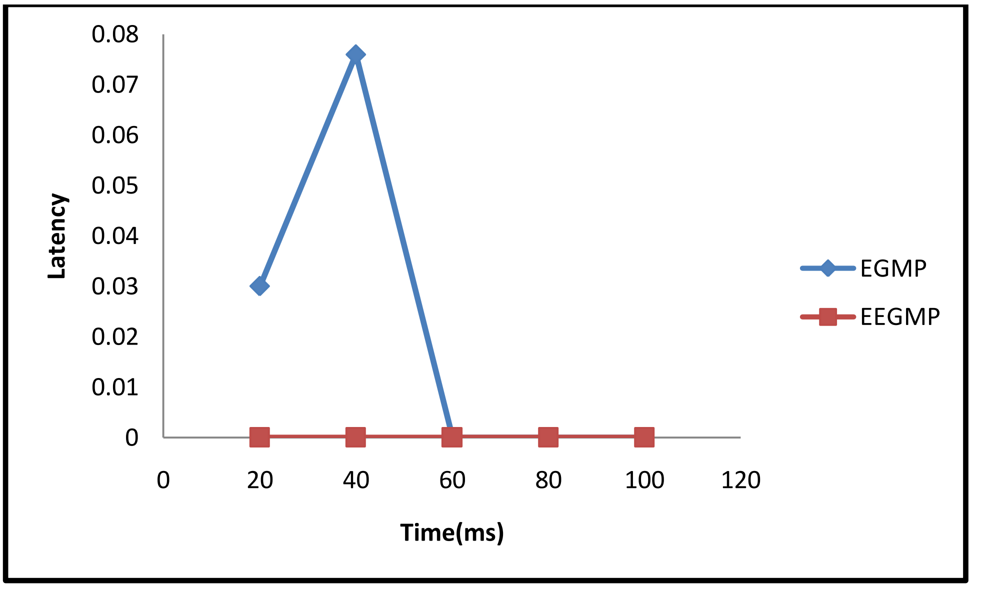
V. SIMULATION STUDY

Simulation study has been carried out using NS-2. The simulation topology contains 50 nodes within an area of 1500 by 1500 meters. The node mobility is modeled using the enhanced Random Waypoint Model. The minimum traveling speed is set to 0.1 m/s and the maximum speed is varied from 2.5 to 15 m/s to represent different levels of nodal mobility. For each maximum speed, 40 scenarios are generated to observe the average performance. Besides, five CBR connections of 18kbps each are introduced to represent the background traffic. The video used is '*highway*', which is a high-motion video trace in Quarter Common Intermediate Format (qcif). The video rate is 10 frames per second (fps) and the packet size is 512 bytes. In this paper, we are not only dealing with the quality of the whole video session but also the latency, throughput, control overhead of each individual packet. Therefore, the occurrence of interruptions during the displaying of the received video is measured.

We ran the simulation environments and evaluated routing overhead, Packet delivery ratio is calculated for EGMP and EEGMP. The results are summarized below with their corresponding graphs

Latency

It is defined as the average time taken by the packet to reach the server node from the client node. The lower value of delay means the better performance of the protocol. Latency differs depending on location of specific pair of communicating nodes. Latency is calculated for both EGMP and EEGMP protocol.



From the Figure 5.1 it is inferred that the latency has been decreased by about 17.2896% than the EGMP algorithm.

Control Overhead

Control overhead is obtained on number of control route request packet and number of route reply packet. Total control packet sent also included in overhead calculation. Overhead does not increase with number of routes being created.

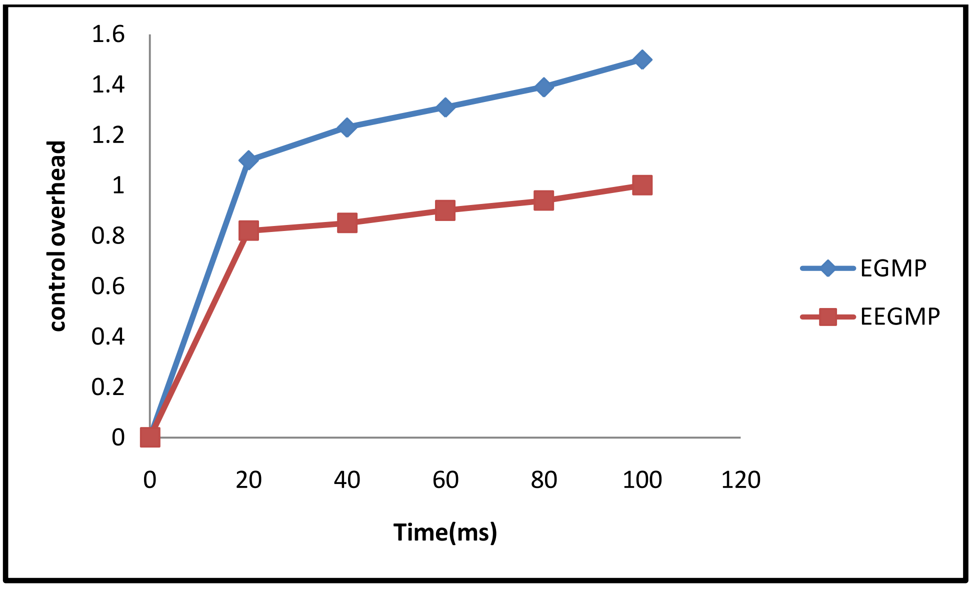


Figure 5.2 shows the proposed method performs better than the existing method for different time intervals. Overhead is calculated and compared between EEGMP and EGMP algorithm. Comparison result shows the overhead decreases by 0.15% for EEGMP algorithm than EGMP algorithm. This indicates number of control packet in transmission is reduced.

The effect of latency and control overhead are measured. From simulation result, it is found that the performance of EEGMP protocol is much better during multicast transmission than for EGMP protocol. Simulation result indicates that latency have been decreased by an amount of 17.3% than the EGMP which implies that video quality is improved in the network, therefore interruption in video playback is reduced. It is also found that the overhead has been decreased by an amount of 0.15% respectively.

CONCLUSION

The major challenges while streaming video over MANETs are latency, control overhead. Latency and control overhead can be reduced by using EEGMP. This paper evaluated the performances of EGMP and EEGMP using ns-2. Comparison was based on latency and control overhead. We conclude that EEGMP is better than EGMP.E EGMP outperforms EGMP due its ability to split the video packets more faster. EGMP incurs more overhead while flooding the network and packet delivery ratio. It is found that latency is reduced, EEGMP is preferred over EGMP.

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