Call level Performance Analysis of Video Streaming Using Different Routing Protocols in MANET

Dr. Kanmani Ruby E. D, Dr. Kasthuri . N, Dheepika G.B

Abstract: A Mobile Ad-hoc Network (MANET) is a dynamic wireless network that can be formed without the need for any pre-existing infrastructure in which each node can act as a router. One of the main challenges of MANET is the design of robust routing algorithms that adapt to the frequent and randomly changing network topology. A real-time video streaming is a challenging task. Here, AOMDV (Ad-Hoc On Demand Multipath Distance Vector) performs multipath multicast which incurs more routing overhead and packet delay. Efficient Geographic Multicast Protocol (EGMP), a multipath multicast protocol is used to implement group membership management and multicast packet forwarding is done. EGMP incurs less Overhead and more delivery ratio than AOMDV. EGMP does not depend on any specific geographic unicast routing protocol. A Call level performance analysis in terms of Throughput, Packet delivery ratio, Flow blocking, Control overhead has been done by comparing AOMDV with EGMP.

Keywords: Ad-hoc networks, Multipath, Multicast, Routing protocols; Simulation.

1. Introduction

MANET is a group of mobile nodes connected through a wireless medium without a central control unit. These nodes can act as both end systems and routers at the same time. When acting as routers, they discover and maintain routes to other nodes in the network. Many applications include military, the firemen in a disaster area, and the support of multimedia games and tele-conferences. With a one-to-many or many-to-many transmission pattern, multicast is an efficient method to realize group communications. In on-demand or Proactive routing protocols, the routes are created on requirement basis. To find a path from source to destination, it invokes the route discovery mechanisms in proactive routing protocol. Reactive routing protocols have some inherent limitations. First, since routes are only maintained while in use, it is usually required to perform a route discovery before packets can be exchanged between communication peers. This leads to a delay for the first packet to be transmitted. Second, even though route maintenance for reactive algorithms is restricted to the routes currently in use, it may still generate an important amount of network traffic when the topology of the network changes frequently. Finally, packets to the destination are likely to be lost if the route to the destination changes [1].

To reduce the topology maintenance over-head in multicasting, an option is to make use of the position information. But there are many challenges to implement an efficient and scalable geographic multicast scheme in MANET. For example, in unicast geographic routing, destination's position is carried in the packet header to guide packet forwarding. But in multicast routing, the destination is a group of members. Putting all the members addresses and positions into the packet header is a direct and easy way, but this is only applicable for the small group case [2] [3] [4]. Besides scalable packet forwarding, a scalable geographic multicast protocol also needs to efficiently manage the membership of a possible large group, obtain the members' positions and forward packets to the members distributed in a possible large network terrain. These are ignored in the above protocols. An efficient geographic multicast protocol (EGMP). It can scale to large group size and network size and can efficiently implement multicasting delivery and group membership management. EGMP uses a hierarchical structure to achieve scalability.

2. Protocol Overview

2.1 Ad-hoc On-demand Multipath Distance Vector Routing (AOMDV)

Ad-hoc On-demand Multipath Distance Vector Routing (AOMDV) [5]protocol is an extension to the AODV protocol for computing multiple loop-free and link disjoint paths. The routing entries for each destination contain a list of the next-hops along with the corresponding hop counts. All the next hops have the same sequence number. This helps in keeping track of a route. For each destination, a node maintains the advertised hop count, which is defined as the maximum hop count for all the paths, which is used for sending route advertisements of the destination. Each duplicate route advertisement received by a node defines an alternate path to the destination. Loop freedom is assured for a node by accepting alternate paths to destination if it has a less hop count than the advertised hop count for that destination.

Because the maximum hop count is used, the advertised hop count therefore does not change for the same sequence number [1]. When a route advertisement is received for a destination with a greater sequence number, the next-hop list and the advertised hop count are reinitialized.

AOMDV can be used to find node-disjoint or link-disjoint routes. To find node-disjoint routes, each node does not immediately reject duplicate RREQs. Each RREQs arriving via a different neighbour of the source defines a node-disjoint path. Here AOMDV is used for video transmission in multipath multicast. It is possible to accommodate the video flow by multiple networks simultaneously. A video streaming flow can be split into multiple sub streams and delivered through multicast schemes simultaneously. The video is multipath multicast using AOMDV as shown in fig.1

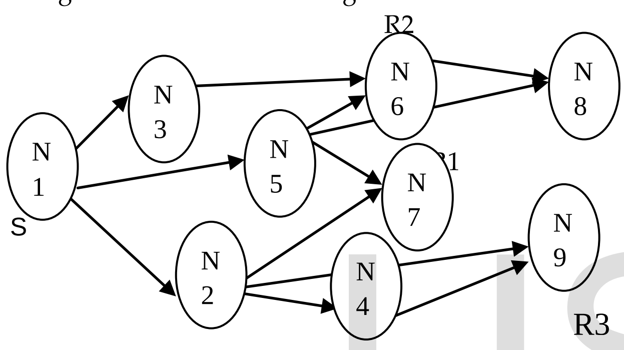

Figure.1 AOMDV in Multipath Multicast Transmission

The AOMDV routing takes place from the source S to the multiple destinations R1, R2 and R3 in multiple paths. The AOMDV algorithm works as follows:

2.1.1 AOMDV Algorithm

STEP1: S is the source node selected and R1, R2 and R3 are the receivers.
STEP2: Multiple paths are selected using Dijikstras algorithm.
STEP3: Source node broadcasts the route request in multipath to the destination receivers R1, R2, R3 through the intermediate nodes.
STEP4: RREQ reaches all the intermediate nodes. If the node recognizes a reliable path requested destination, it replies to the source node with a RREP message.
STEP5: If that particular node is not the destination, then it checks whether there is any valid path available for the destination. If it exists, it forwards the RREQ message to that node.
STEP6: After forwarding RREQ to the destination, the node appends its own address to a list of traversed hops and broadcasts the updated RREQ.
STEP7: Thus after getting the RREP message from that node, the specified path is available for the transmission. If the source node receives the RERR message, that path won't be used for the data transmission.
STEP8: In Multipath data transmission, QoS parameters for each path is calculated and the path which has got the highest QoS will be used for transmission.
STEP9: Redundant paths are identified and suitable path is randomly selected.

2.2 Efficient Geographic Multicast Protocol

Group communications is important in supporting multimedia applications. Multicast is an efficient method in implementing the group communications. How-ever, it is challenging to implement efficient and scalable multicast in Mobile Ad hoc Networks (MANET) due to the difficulty in group membership management and multicast packet forwarding over the dynamic topology. Here a novel Efficient Geographic Multicast Protocol (EGMP) uses a hierarchical structure to implement scalable and efficient group membership management. Video is multipath multicast using this system.

In EGMP each zone may join or leave a multicast group as required. From that a network wide zone-based multi-cast tree is built. Each zone is given a zone id. For efficient and reliable transmissions, location information will be integrated with the design and used to guide the zone construction, group membership management, multicast tree construction and packet forwarding. The zone-based tree is shared for all the multicast sources of a group[11]. To further reduce the forwarding overhead and delay, EGMP supports bi-directional packet forwarding along the tree structure. That is, instead of sending the packets to the root, a source forwards the multicast packets directly along the tree. At the upper layer, the multicast packets will flow along the multicast tree both upstream and downstream. At the lower layer, when an on-tree zone leader receives the packets, it will send them to the group members in its local zone [10][11].

2.2.1 Notations and Definitions

***Zone*:** The network terrain is divided into square zones as shown in Fig. 2.
S: Zone size, the length of a side of the zone square. The zone size is set to $S \leq St/\sqrt{2}$, where *St* is the transmission range of the mobile nodes. To reduce intra-zone management overhead, the intra-zone nodes can communicate directly with each other without the need of any intermediate relays.

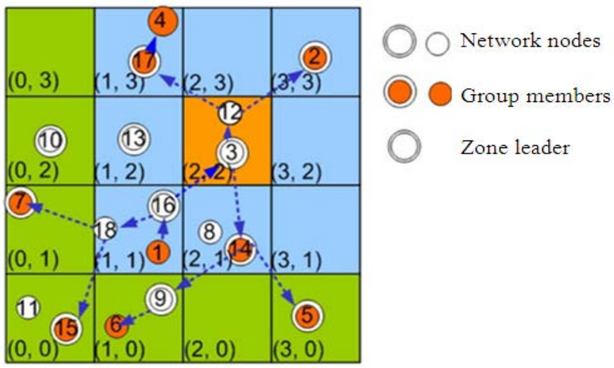

Fig.2 Zone structure and Multisession

***Zone ID*:** The identification of a zone. A node can calculate its zone ID (a, b) from its position coordinates (x, y) as: $a = [(x-x0)/s]$, $b = [(y-y0)/ s]$, where $(x0; y0)$ is the position of the virtual origin, which can be a known reference location or determined at network setup time. A zone is *virtual* and formulated in reference to the virtual origin. For simplicity, we assume all the zone IDs is positive.

***Zone center*:** For a zone with ID (a,b), the position of its center $(xc; yc)$ can be calculated as: $xc = x0 + (a+ 0.5)* r$, $yc = y0 + (b + 0.5) * r$. A packet destined to a zone will be forwarded towards the center of the zone.

zLdr: Zone leader. A zLdr is elected in each zone for managing the local zone group membership and taking part in the upper tier multicast routing.

Tree zone: The zones on the multicast tree. The tree zones are responsible for the multicast packet forwarding. A tree zone may have group members or just help forward the multicast packets for zones with members.

root zone: The zone where the root of the multicast tree is located.

zone depth: The depth of a zone is used to reflect its distance to the root zone. For a zone with ID $(a; b)$, its depth is: $depth = \max(|a0 - aj|, |jb0 - bj|)$; where $(a0; b0)$ is the root-zone ID. For example, in Fig. 2, the root zone has *depth* zero, the eight zones immediately surrounding the root zone have *depth* one, and the outer seven zones have *depth* two.

2.2.2 Moving between Different Zones

When a member node moves to a new zone, it must rejoin the multicast tree through the new leader. When a leader is moving away from its current zone, it handover its multicast table to the new leader in the zone, so that all the downstream zones and nodes will remain connected to the multicast tree. Whenever a node moves into a new zone, it will rejoin a multicast group by sending a JOIN_REQ message to its new leader. During this process in order to reduce the packet loss, the node broadcasts a BEACON message to update its information and a copy of the message to the leader of its previous zone to update its position. Since it has not sent the LEAVE message to the old leader, the old leader will forward the multicast packets to nodes it reduce packet loss. When the rejoining process finishes, node will send a LEAVE message to its old leader.

To handle leader mobility problem, if a leader finds its distance to the zone border is less than a threshold or it is already in a new zone, it assumes it is moving away from the zone where it was the leader, and it starts the handover process. To look for the new leader, it compares the positions of the nodes in the zone it is leaving from and selects the one closest to the zone centre as the new leader. It then sends its multicast table to the new leader, which will announce its leadership role immediately through a BEACON message. It will also send a JOIN_REQ message to its upstream zone. During the transition, the old leader may still receive multicast packets. It will forward all these packets to the new leader when the handover process is completed. If there is no other node in the zone and the zone will become empty.

In the case that the leader dies suddenly before handing over its multicast table, the down-stream zones and nodes will reconnect to the multicast tree through the maintenance process. Empty zone is the root zone, since the root zone has no upstream zone, the leader will check its neighbouring zones and choose the one closest to the root zone as the new root zone. The leader then forwards its multicast table to the new root zone, and floods a NEW_ROOT message to announce the change.

In this paper the Efficient Geographic Multicast Protocol (EGMP) uses a hierarchical structure to implement scalable and efficient group membership management. Video is multipath multicast using this system as follows.

2.2.3 EGMP Algorithm

STEP 1: Source node initiates the whole network by sending the message NEW_SESSION.
STEP 2: The network is divided into different zones.
STEP 3: If the source node is not a leader node it sends a JOIN_REQ message to its zone leader, carrying its address, position and group to join.

STEP 4: After the node has joined the zone it sends the multicast packets to its zone leader in multipath.

STEP 5: Multipath is selected using the shortest path algorithm.

STEP 6: After selecting the shortest path the zone leader forwards the packet to the
respective destination zone leader.

STEP 7: The zone leader may receive duplicate multicast packets from different upstream zones. Therefore, when the two upstream zones have the same distances to the root zone one of them is randomly selected.

STEP 8: Zone leader sends the packet to the destination node. The destination node ends the session by sending the END_SESSION message.

3. 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.

4. Performance Evaluation

The evaluations are based on the simulation of 100 wireless mobile nodes forming an ad hoc network, moving about over a square (1000m x 1000m) flat space for simulated time. A square space is chosen to allow free movement of nodes with equal density. We choose the traffic sources to be constant bit rate (CBR) source. The source and destination pairs were spread randomly over the network. In the simulation, node movement is due to random waypoint model.

4.1 Performance Evaluation Metrics

Comparing the performance of AOMDV and EGMP according to the following performance metrics: Throughput, Packet delivery ratio, Flow blocking.

4.2 Simulation Results

For different Simulation environments throughput packet delivery ratio, Flow blocking for AOMDV and EGMP are evaluated. The results are summarized below with their corresponding graphs.

4.2.1. Packet delivery ratio*:* The ratio of the number of packets received and the number of packets send.

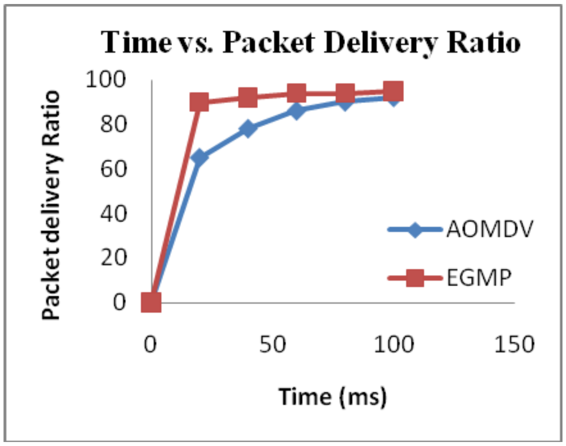

Figure.3 Comparison of AOMDV and EGMP on basis of packet delivery ratio

From the Figure.3 EGMP achieves 2% higher packet delivery ratio than AOMDV, hence reliability is better than AOMDV.

4.2.2 Throughput: Maximum rate of data that an network can accept. EGMP reduce the packet drop up to 30%, whereas AOMDV is about 40%.

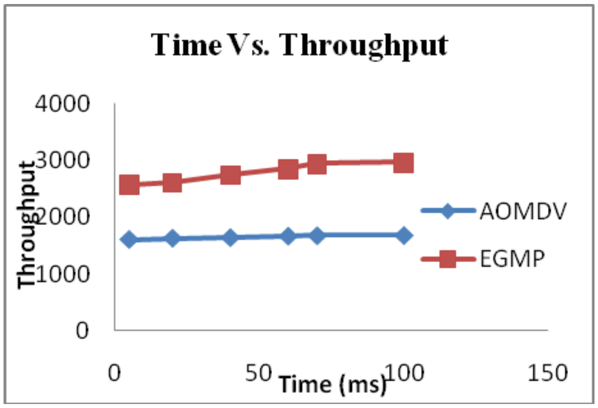

Figure.4 Comparison of AOMDV and EGMP on basis of Throughput

From the Figure.4 EGMP achieves 20% higher throughput than AOMDV

4.2.3 Flow Blocking: If a queue is full when a packet arrives, it will be discarded, or "blocked". So the probability that a packet is blocked is exactly the same as the probability that

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the queue is full.

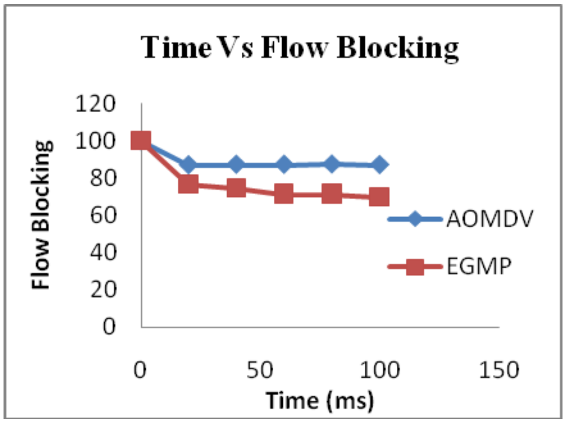

Figure.5 Comparison of AOMDV and EGMP on basis of Flow blocking

In Figure.5 EGMP, blocking probability is 2% less compared to AOMDV. The packet drop is reduced in EGMP improving the efficiency of the network.

4.2.4 Control Overhead:

Overhead can be used for a wide variety of purposes, such as channel separation, addressing, error control and priority indication. Although overhead is essential to the integrity of data storage and transmission, it reduces the amount of user data that can be stored or transmitted.

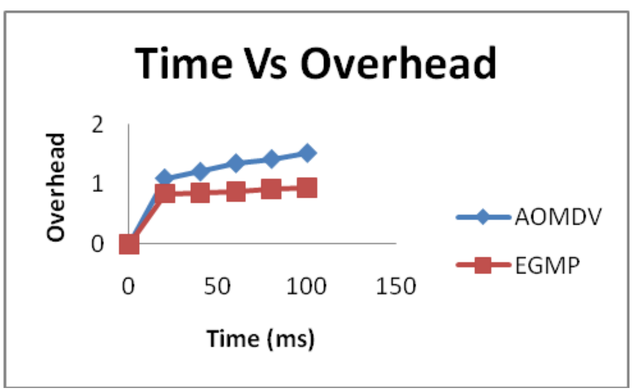

Figure.6 Comparison of AOMDV and EGMP on basis of Control overhead

In Fig.6 EGMP has less overhead than AOMDV. So, data will be transmitted more.

5. Conclusion

In this paper, the problem of video transmission in multipath multicast communication over wireless adhoc networks has been analyzed. EGMP for multipath video multicast provides robustness for video applications. Simulation results show that the throughput of the multiple path multicast video using EGMP is significantly 20% higher than that of AOMDV video communication. The simulated results proves by adopting EGMP protocol the QoS parameters, viz Throughput, Packet delivery ratio, Flow blocking has been significantly improved. Throughput has been increased by 20% for EGMP than AOMDV. It is also found that packet delivery ratio increased by 2% for EGMP and flow blocking is reduced by 2% for EGMP. Wireless multicast is required for a range of emerging wireless applications employing group communication among mobile users. Exata is a tool to implement video streaming in real-time.

6. References:

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