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EVSM: Enhanced Video Streaming in Mobile Ad-hoc Networks

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***Abstract*— Real time video streaming over wireless networks is an increasingly important and attractive service to the mobile users. Video streaming involves a large amount of data to be transmitted in real time, while wireless channel conditions may vary from time to time. It is hard to guarantee a reliable transmission over the wireless network. Bandwidth, packet loss, packet delays, and outage times are the parameters specifying the transmissions. The quality of the video is affected negatively when network packets are lost. The mobile users may notice some sudden stop during the video playing. Some times the picture is momentarily frozen, followed by a jump from one scene to another. Wireless Ad-hoc Network is promising in solving many challenging real-world communication problems. Examples of these are: military field operation, emergency response system, and oil drilling and mining operation. However, the wide deployment of this type of network is still a challenging task. It is very difficult to manage quality of services for real time applications like video transmission over mobile nodes. Mobile ad hoc networks are not so resilient and reliable because of their dynamic topology due to the mobile nodes and impact of environmental circumstances. However, it provides multiple routes from the source to the destination, which gives extra redundancy for video and data transmission. The main objective of this paper is to enhance video streaming quality in mobile Ad-hoc networks. Simulation experiments are carried out using Network Simulator version 2 (NS-2.34) on Ad-hoc On-demand Multipath Distance Vector Routing Protocol (AOMDV).**

***Index Terms*— Ad-Hoc Network, AOMDV, MANETs and NS**

I. INTRODUCTION

WIRELESS devices form a network as they become aware of each other's presence. They communicate directly with devices inside their radio range in a peer-to-peer nature. If they wish to communicate with a device outside their range, they can use an intermediate device or devices within their radio range to relay or forward communications to the device outside their range. An Ad-hoc network is self-organizing and adaptive [1], [2], [3]. Networks are formed on-the-fly, devices [18] can leave and join the network during its lifetime, devices can be mobile within the network, the network as a whole may be mobile and the network can be deformed on-the-fly. Devices in mobile ad hoc networks should be able to detect the presence of other devices and perform the necessary set-up to facilitate communications and the sharing of data and services.

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Fig. 1: Mobile Ad-hoc Networks [1]

A. *Video Streaming*

It refers to the consumption of video data while it is being delivered. A video stream can be live or on demand. Live Streaming refers to streaming of data from a live event, where the media data is not stored for a period of time before it is distributed. Streaming is necessary to enable viewing of live multimedia content. On-demand Streaming refers to streaming of non-live media, where the media data is stored and transmitted to the user upon request. The demand for multimedia content in general has steadily increased since the introduction of broadband Internet services for home customers, and as bandwidth continues to increase, so does the demand for multimedia content. During the last few years, downloading of video songs and eventually movies, has become commonplace. Eventually, high bandwidth and low latency has made streaming of these media feasible, and live multimedia applications such as Internet telephony, or Voice over IP (VoIP), has become popular through applications such as Skype. The introduction of 3G mobile telephone networks and growing concerns about global warming have also brought increased attention to video telephony and video conferencing. But the increased and demand for streaming video content places new demands on the network infrastructure and end-systems. This is because, in contrast to traditional content, Video Streaming requires a certain Quality of Service (QoS) [4]. To properly support streaming of multimedia, parameters such as available memory, processing power and bandwidth must be taken into account. Transmission of video streams across channels that are unable to fulfill the resource requirements, results in choppy playback and a bad user experience. Video Transmissions over wireless networks are based on two modes, namely downloading and streaming. In download mode, a user downloads the entire video file from the video server and then plays the video file. However, the download mode usually suffers from long and unacceptable transfer time. For streaming mode, all video content does not need to be downloaded before viewing. Instead it is being played when there is an available amount of video frames are being received and decoded by client terminal [4], [5]. Video Transmission requires a steady flow of information and delivery of packets by a deadline. However, wireless radio networks have difficulties to provide a reliable service [6]. Video Transmission over a dynamic channel, like mobile wireless networks, is much more difficult than over a static channel since the delay and packet loss are not known in advance [7]. Therefore, the wireless networks need some effort in order to use radio resources efficiently [8]. The availability of multiple channels for wireless communication provides an excellent opportunity for performance improvement. The term multiple channels refers to wireless technology that can use more than one radio channel, and multiple channels have been advocated as one approach for enhancing network capacity [9]. The advantages of using of multiple channels over a single channel are to improve performance of limited bandwidth and to increase the channel capacity for video transmission [10].

B. *Multipath Schemes*

Routing is responsible to establish and maintain possible end-to-end paths from source to destination. The main challenge in video streams is to classify the routes that ensure the video delivery with a satisfying quality. In general, Multipath routing can improve QoS by providing the following:

- *Accumulation of bandwidth and delay:* breaking the capacity of more than one route.
- *Route load balancing:* balance the traffic load in higher number of nodes.
- *Fault tolerance:* by adding redundancy, to reduce the effect of network failures onto affected video quality, it is important that the paths are disjoint. In case the Multipath routing protocol offers multiple paths with sufficient path diversity, it is less probable that a link failure affecting one of the paths simultaneously affects one of the other paths. This is especially beneficial in real-time streaming, where the playback buffer is limited and the video coder no longer can rely only on time diversity.

II. LITERATURE SURVEY

A. *Ad-hoc On-demand Multipath Distance Vector Routing Protocol (AOMDV)*

AOMDV [11] shares several characteristics with Ad-hoc On-demand Distance Vector Routing Protocol (AODV). It is based on the distance vector concept and uses hop-by-hop routing approach. Moreover, AOMDV also finds routes on demand using a route discovery procedure. The main difference lies in the number of routes found in each route discovery. In AOMDV, Route Request (RREQ) propagation from the source towards the destination establishes multiple reverse paths both at intermediate nodes as well as the destination. Multiple Route Replies (RREPs) traverse these reverse paths back to form multiple forward paths to the destination at the source and intermediate nodes. The core of the AOMDV protocol lies in ensuring that multiple paths discovered are loop-free and disjoint, and in efficiently finding such paths using a flood-based route discovery. AOMDV route update rules, applied locally at each node, play a key role in maintaining loop-freedom and disjoint ness properties. Here the main ideas to achieve these two desired properties. Next subsection deals with incorporating those ideas into the AOMDV protocol including detailed description of route update rules used at each node and the multipath route discovery procedure. AOMDV relies as much as possible on the routing information already available in the underlying AODV protocol, thereby limiting the overhead incurred in discovering multiple paths.

Destination	Sequence number	Hop count	Next hop	Timeout

(a) AODV

Destination	Sequence no.	Advt hop count	Route list			
			next_hop1 next_hop2 …………	last_hop1 next_hop2 …….......	hop_count1 hop_count2 ……………	timeout1 timeout2 ………..

(b) AOMDV

Fig. 2: (a) AODV Routing table, (b) AOMDV Routing table

Fig. 2 shows the difference in the routing table entry structure between AODV and AOMDV. AOMDV route table entry has a new field for the advertised hop count. Besides a route list is used in AOMDV to store additional information for each alternate path including: next hop, last hop, hop count, and expiration timeout. As already discussed, last hop information is useful in checking the disjoint ness of alternate paths.

Consider a destination *d* and a node *i*. Whenever the destination sequence number for *d* at *i* is updated, the corresponding advertised hop count is initialized. For a given destination sequence number, let hop $count^{d}_{ik}$ denote the hop count of kth path (for some k) in the routing table entry for d at *i*, that is ($next\_hop^{d}_{ik}$, $last\_hop^{d}_{ik}$, $hop\_count^{d}_{ik}$) $\in$ $route\_list^{d}_{i}$. When *i* is about to sends its first route advertisement for *d*, it updates the advertised hop count as follows:

$$advertised\_hop\_count^{d}_{i} := \max \{hop\_count^{d}_{ik}\},\ i \neq d$$
$$:= 0, \text{ otherwise.}$$

- *Route discovery*

As in AODV, when a traffic source needs a route to a destination, the source initiates a route discovery process by generating a RREQ. Since the RREQ is flooded network-wide, a node may receive several copies of the same RREQ. In AODV, only the first copy of the RREQ is used to form reverse paths; the duplicate copies that arrive later are simply discarded. Note that some of these duplicate copies can be gainfully used to form alternate reverse paths. Thus, all duplicate copies are examined in AOMDV for potential alternate reverse paths, but reverse paths are formed only using those copies that preserve loop-freedom and disjoint ness among the resulting set of paths to the source. This is ascertained by applying the route update rules. When an intermediate node obtains a reverse path via a RREQ copy, it checks whether there are one or more valid forward paths to the destination. If so, the node generates a RREP and sends it back to the source along the reverse path; the RREP includes a forward path that was not used in any previous RREPs for this route discovery. In this case, the intermediate node does not propagate the RREQ further. Otherwise, the node re-broadcasts the RREQ copy if it has not previously forwarded any other copy of this RREQ and this copy resulted in the formation/updation of a reverse path. When the destination receives RREQ copies, it also forms reverse paths in the same way as intermediate nodes. However, it adopts a somewhat ‘looser’ policy for generating a RREP. Specifically, the destination generates a RREP in response to every RREQ copy that arrives via a loop-free path to the source even though it forms reverse paths using only RREQ copies that arrive via loop-free and disjoint alternate paths to the source. The reason behind the looser RREP generation policy at the destination is as follows. The RREQ flooding mechanism, where each node locally broadcasts a RREQ once, suppresses some RREQ copies at intermediate nodes and duplicates other RREQ copies.

- *Route maintenance*

Route maintenance in AOMDV is a simple extension to AODV route maintenance. Like AODV, AOMDV also uses Route Error (RERR) packets. A node generates or forwards a RERR for a destination when the last path to the destination breaks. AOMDV also includes an optimization to salvage packets forwarded over failed links by re-forwarding them over alternate paths. This is similar to the packet salvaging mechanism in Dynamic Source Routing (DSR). The timeout mechanism similarly extends from a single path to multiple paths although the problem of setting proper timeout values is more difficult for AOMDV compared to AODV. With multiple paths, the possibility of paths becoming stale is more likely. But using very small timeout values to avoid stale paths can limit the benefit of using multiple paths. In some experiments, the use of moderate setting of timeout values and additionally use HELLO messages to proactively remove stale routes. Thus, the timeouts in the current version of AOMDV primarily serve as a soft-state mechanism to deal with unforeseen events such as routing table corruption and to a lesser extent for promptly purging stale routes. An adaptive timeout selection mechanism for purging stale cached routes in DSR, which can be applied to AOMDV with appropriate modifications. As an alternative, timeout selection can be based on analytical characterization of link behavior in ad hoc networks.

- *Data packet forwarding*

For data packet forwarding at a node having multiple paths to a destination, A simple approach of using a path until it fails and then switch to an alternate path. There are other alternatives for data packet forwarding which concurrently use all paths. With ‘diversity coding’ an overhead is added to each data packet (coding) and the resulting coded packet is split into smaller blocks each of which is transmitted along a different path. With adequate redundancy, this scheme can improve the packet delivery probability in highly dynamic mobile networks. This scheme can also employ in a selective way to ensure delivery of ‘important’ packets. In another alternative, alternate paths are used simultaneously for ‘load balancing’ where data packets are distributed over the available paths, thereby improving the network utilization and end-to-end delay. In addition to the well-known issues of adaptive traffic splitting across multiple paths and dealing with the possibility of packet re-ordering, effective load balancing in ad hoc networks has to address the unique problem of ‘route coupling’ arising from interference between alternate paths.

B. Related Work

[12] Proposed a proactive link protection and receiver-oriented adaptation technique. Initially, the source node discovers a route to its destination node. After path discovery process source node starts to send data to the destination node. Initially source node may need to set hop_cnt = 0 of a packet and incremented each time when the packet is retransmitted and dest_pos field is used for piggybacking the location of the destination node. Whenever the destination node receives a packet, it includes its current location in its ACK packet. This location information is piggybacked to the source node. Mobility of nodes may cause path burst which

results into streaming interruption. This problem is undertaken by two new techniques [13]. Proactive Link Protection is aimed at replacing a link that is about to break by proactively looking for an alternative one. Receiver-Oriented Adaptation: - The idea behind this technique is making a straight path from source to destination with minimum no. of hops. In ideal case hop_cnt can be calculated using this equation [L/R], where L is the length of the connection line, and R is the transmission range.

[14] Proposed two multichannels routing protocols. The first multichannels routing protocol is based on single-path routing. This routing protocol suppresses the intrapath interference in a collision avoidance network or carrier sense multiple access network. The above routing protocol is developed by using link-partitioning scheme where the neighbor nodes operate at different non overlapping frequency bands. A technique, named systematic channel assignment, for this approach shows that the partitioning scheme can substantially amplifies the throughput performance of a multihop link. The second multichannels routing protocol is invented for transmission of real-time traffic over multiple-path routes. In mobile ad hoc networks, especially for real-time traffic, this approach can be affected unfortunately from co-channel interference due to the concurrent transmission of packets via multiple routes. So a dual-path routing protocol is developed, which guarantees a different frequency band for each path, thus eliminating interpath interference. This protocol reduces the possibility of losing all the routes at the same time. Both, dual-description video coding [15] and the above described routing protocols can enhance the performance of real time video transmission over ad-hoc networks.

[16], [17] proposed a multipath multimedia dynamic source routing (MMDSR) technique. Using this technique, the source sends a Probe Message (PM) packet to destination through each one of the paths discovered by DSR. A time-out is triggered upon the arrival of the first PM packet at destination. The PM packets received after timeout are discarded, because these packets arrived through a path having too much delay. After time-out, a Probe Message Reply (PMR) packet generated by destination node contains a set of sampled values of the QoS parameters collected from all the PM packets that arrived in time. The PMR message is sent back to the source through each one of the paths through which a PM arrived. This information will be analyzed at the source, where paths as categorized as best_path, medium_path, wrost_path. Then, the packets are sent according to their priorities as highest priority packets through best_path, medium priority through medium_path and lower priority through wrost_path.

III. EVSM: ENHANCED VIDEO STREAMING IN MANETS

Challenges of MANETs are to rely on all participating nodes to take on the task of routing and forwarding peer traffic. The nodes can move arbitrarily. As a result, discovering and maintaining optimal routes is a central challenge to MANETs, because the node mobility can cause links to break and re-establish arbitrarily. Initial problems occur in video streaming as it moves from the wired onto the wireless medium, as wireless links generally have much higher error rates and unpredictably time-varying characteristics. The most significant challenges nevertheless occur while streaming across multihop wireless networks with mobile nodes, due to the problem of discovering and sustaining reliable paths. Traditional challenge is to ensure a satisfactory audio/video experience.

A. EVSM Algorithm

Step1 Send request for a particular destination.
Step2 Destination will send reply consisting hop count of route.
Step3 Re-arrange these available routes in ascending order according to their Hop Count.
Step4 Update routing table according to the re-arrangement.
Step5 Divide the traffic into 60:40 on available routes as less hop count routes will assign more traffic.
Step6 Now transmit data according to the above division ratio through discovered routes.

As in this Algorithm EVSM is purely based on traffic splitting in multiple routes. The key point is to use the maximum ability of best routes and reduce the load of long or error prone routes. As if any route is having less no. of hopes then the chances of route drop are also low. To ensure the better video streaming quality, routes should have less delay, less packet loss and long stability. So as in this technique firstly routes are discovered and then these available routes are rearranged in ascending order according to their hop counts. And traffic is divided into 60:40 in these routes. It means if we have minimum 2 routes from source to destination then 60% of traffic will be send through 1^{st} route and remaining 40% will be send through 2^{nd} route. But if no. of routes are N then traffic is divided into N-1 routes and remaining traffic is assigned to the N^{th} route. So this ensures the large amount of data receive with less packet loss and less delay. This technique is implemented on AOMDV which is on demand multipath routing protocol.

IV. RESULTS

To evaluate the performance of the Modified-AOMDV routing protocol, NS2 [20] was used. In this simulation, we created 5-scenario for 20 mobile nodes. In the scenario, nodes are chosen randomly. To evaluate the performance of Modified-AOMDV node mobility was varied from 50 m/s to 250 m/s. Simulation time was kept 500 sec in the scenario and UDP connection was established along with CBR traffic generator having packet size 512 and bit rate 10 kbps.

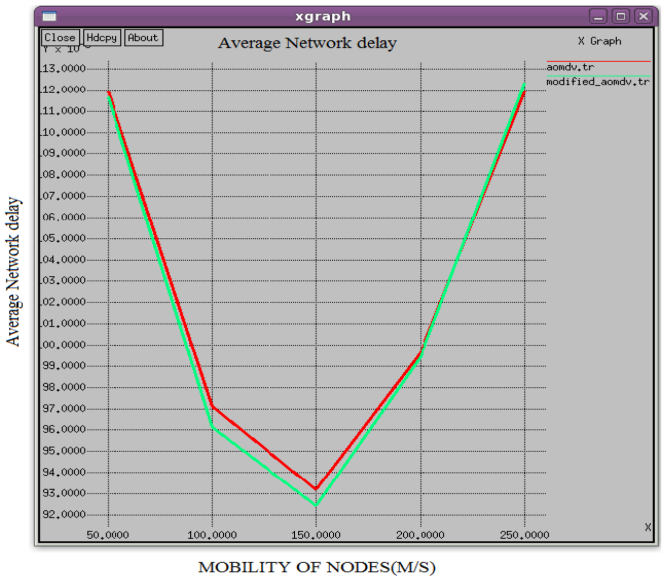

Fig. 3: Average Network Delay V/S Node Mobility

Average Network Delay in case of AOMDV depends on the protocol routing procedure and number of nodes involved. In Fig. 3, delay in case of node mobility of 0 to 200 m/s for AOMDV is high then Modified_AOMDV. But in case of node mobility of 200 to 250 m/s the Average Network Delay of Modified_AOMDV increases.

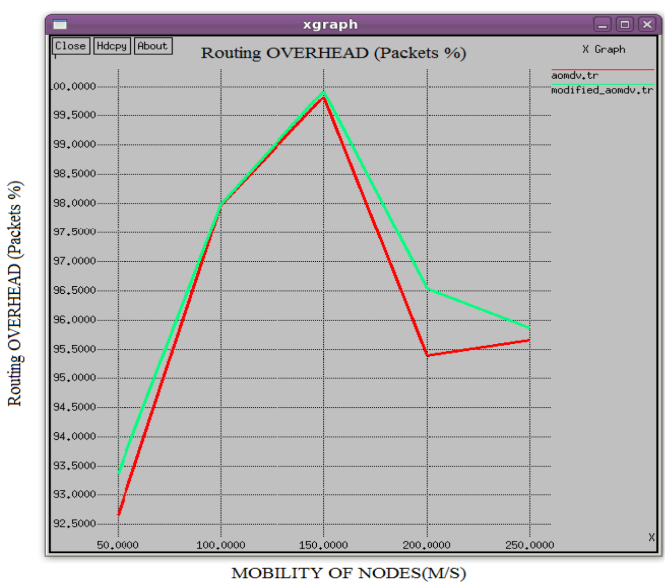

Fig. 4: Routing Overhead V/S Node Mobility

In case of Routing Overhead Fig. 4 shows that Modified_AOMDV has a high Routing Overhead as compare to that of AOMDV. This is different at different speeds. At high speeds the routing protocols take much more time for adjusting and afterward sending of traffic to the new routes. In case of higher node mobility AOMDV react more quickly as compare to Modified_AOMDV which made the difference in Routing Overhead much wider.

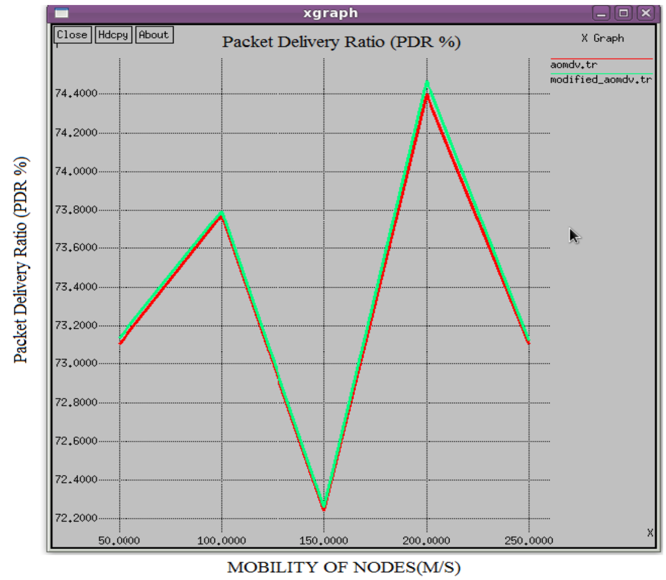

Fig. 5: Packet Delivery Ratio V/S Node Mobility

Packet Delivery Ratio in case of Modified_AOMDV depends on the protocol routing procedure and number of nodes involved. In Fig. 5, Packet Delivery Ratio in case of where mobility has max value 200 m/s for Modified_AOMDV is very high compared to existing AOMDV. Packet Delivery Ratio increases with increases in node mobility but it decreases after 200 m/s.

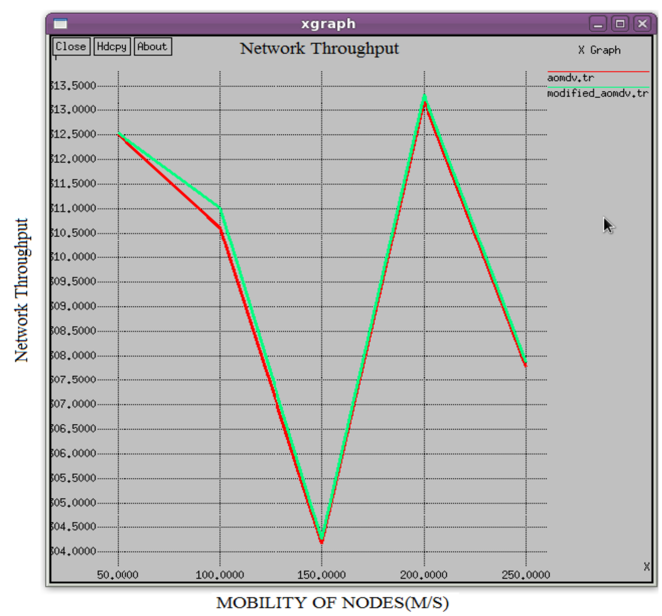

Fig. 6: Network Throughput V/S Node Mobility

Fig. 6 shows high throughput for Modified_AOMDV compared to AOMDV for 20 nodes. This is because of the less data traffic on more error prone routes. So data delivery is higher and packet loss is very less than the traditional AOMDV protocol.

V. CONCLUSION AND FUTURE WORK

Video streaming system must account for the anomalies of packet loss and delay that make the delivery of video on MANETs challenging. In this paper the effect of network throughput, average network delay, routing overhead and packet delivery ratio on AOMDV and Modified-AOMDV are analyzed. Using this proposed technique, streaming system adapts to changing network conditions and delivers enhanced video quality. While many questions and challenges still remain regarding enhancing video streaming quality over MANETs.

Future work includes finding a scalable method of building real-world MANETs testbeds, and incorporating mobility into the testbed. This would then allow exploring the effects of mobility and route changes during a MANETs streaming experiment. As in performance evaluation routing overhead is also increased in proposed technique so it will be better to decrease this overhead to increases the performance of proposed technique. The trial on a static setup is not very realistic, so this is very interesting and important work. As the size of the network increases and mobility is introduced, it will also become increasingly difficult to obtain complete wireless traces of the network in a reliable manner. A method of capturing link layer information locally on each node would be preferable, but it is unclear whether this is possible.

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