Performance Analysis of Multi-path routing protocols for Multimedia Transmission over MANETs

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Abstract - Mobile Ad hoc networks (MANETs) are considered very attractive for many applications. Advances in Wireless LAN technology and growing interest in mobile ad hoc networks for sensitive operations such as first responders and disaster recovery have created new demands of delivery of voice and video services over ad hoc channels. Multimedia transmission over MANETs is quite challenging task because of bit rate, bandwidth constraints. In order to overcome these constraints in this work, multipath routing protocols DSR and AOMDV have been used to transmit multimedia data as they allow load balancing and faster delivery. Moreover performance analysis of these protocols (DSR and AOMDV) has been carried out in the said work for different parameters including end-to-end delay, throughput and packet loss.

Key Words: MANETs, DSR, AOMDV, Multipath Routing, Multimedia transmission.

I. INTRODUCTION

Ad hoc Networks are a new model of wireless communication for mobile hosts (called nodes). Ad hoc networks do not require fixed infrastructure such as base stations or mobile switching centers. Mobile ad hoc network (MANET) is a self-configuring infrastructure less network of mobile devices connected via wireless links. In MANETs, the devices are free to move independently in any direction, and therefore are having a dynamic topology. These devices moreover are allowed to come in and leave the network anytime. Since the mid-1990s MANETs are becoming very popular among researchers because they are able to operate in standalone manner or can be linked to larger internet [1]. MANET is the new incipient technology which can enable the users to communicate regardless of their physical location. Increase in the low-priced, small and powerful devices such as notebooks make MANET a fast growing network. The applications of MANETs are miscellaneous, ranging from large-scale, mobile, and highly dynamic networks to small networks that are constrained by power sources. MANETs are categorized as: Vehicular Ad hoc Networks (VANET), Internet based MANETs (IMANET) and Intelligent Vehicular Ad hoc Networks (INVANET). Among these former is most interesting as they possess a wide number of applications [2]. The ground breaking applications of MANETs are: Educational applications (Virtual classrooms, video conference rooms) in Universities and campus, Tactical Networks used in military operations, battle fields and rescue operations and the entertaining multi-user games, robot pets etc.

Multimedia transmission is one of widely held topic by researchers in MANETs since the rapid growth in the wireless technology led to the demand of delivery of voice and video services over MANETs. Due to the varying network topology in MANETs, many difficulties arise due to which a real time end-to-end communication cannot be easily accomplished. Even at times when the connectivity between the nodes does exist, the transmission of real time multimedia traffic suffer from significant delay and large packet loss. Routing protocols therefore, play an important role in network communications [3]. The most prevalent routing strategy in ad hoc networks is on-demand routing. Instead of, exchanging route messages occasionally to maintain permanent route table of full topology, the protocols based on on-demand routing build routes only when a node needs to send data packets to a destination. Since no periodic route table exchange is required, control overhead is minimized and the routing information is utilized efficiently. Most proposed protocols of this type are Dynamic Source Routing (DSR) and Ad hoc On-demand Distance Vector (AODV) [4].

The main objectives of a protocol are: to discover the paths and to maintain these paths during the transmission of data packets. Whenever there is route failure, the protocol must initiate a new route discovery process and start retransmission. One of the greater solutions for this is the use of multi paths. Since the multi path transmission can distribute the traffic between a set of disjoint paths, it offers load balancing as well as route failure defense. So among various route error resilient techniques, protocols with path diversity are found to be hopeful method for transmitting multimedia over MANETs [5].

Many MANET multipath routing protocols have been proposed so far and investigated by researchers in order to find the routing protocol that suits better for transmitting multimedia over mobile ad-hoc networks. In this work, we investigated the two of such multipath routing protocols: 1) Ad hoc on-demand Multipath Distance Vector routing (AOMDV) [6] and 2) Dynamic Source Routing (DSR) [7]. We present a comparison of the said protocols based on some performance characteristics. End-to-end delay, packet loss and throughput of the two protocols for same network scenario are taken into concern.

We conducted simulations in NS2 (Network Simulator) [8] to study the performance of mentioned routing algorithms. Since NS2 does not support the real time video transmission, video trace file is used instead. The video packets are transmitted from source to destination under different conditions and at the same time normal CBR traffic is considered likewise. The parameters cited above are evaluated and compared experimentally. Finally, it is concluded that among DSR and AOMDV, the former one is more suitable for multimedia transmission over MANETs as compared to later one.

The rest of the paper is systematized as follows: Section II contains related work and architecture, section III consists of Routing protocols, performance evaluation and comparison are described in section V and section VI concludes the paper.

II. RELATED WORK

Multimedia streaming in MANETs from different viewpoints are found in literatures. It is perceived that most of the routing protocols originate from DSR and AODV [9] protocols. We present a comparative analysis of DSR and AOMDV (an extension of AODV protocol for multipath) protocol. Other established protocols have not been analysed in this work. The performance of these routing protocols has been investigated for video transmission in terms of some popularly used QoS parameters. These performance parameters used are namely the throughput, end-to-end delay and packet loss. Network is simulated using NS2 simulator and consists of 20 nodes. The network area is 500*500 m.

Architecture: The general architecture of our work carried is depicted by the **Figure: 1**. This illustrates the multi path transport of video data from source to destination. The raw video is first encoded by a multi-stream coder. Resulting video trace file is transmitted to destination along multiple paths. The flow is partitioned and assigned to multiple paths by the traffic allocator. These paths are maintained by the multi path routing protocol. When the flow arrives at receiver end, it is sequenced by a re-sequencing buffer for giving it the original order. Finally the video is extracted from the buffer to be decoded. We assume there exist multiple paths between source and destination. The protocols used work on these multiple paths in interest of providing the trusted paths for transmission of multimedia data.

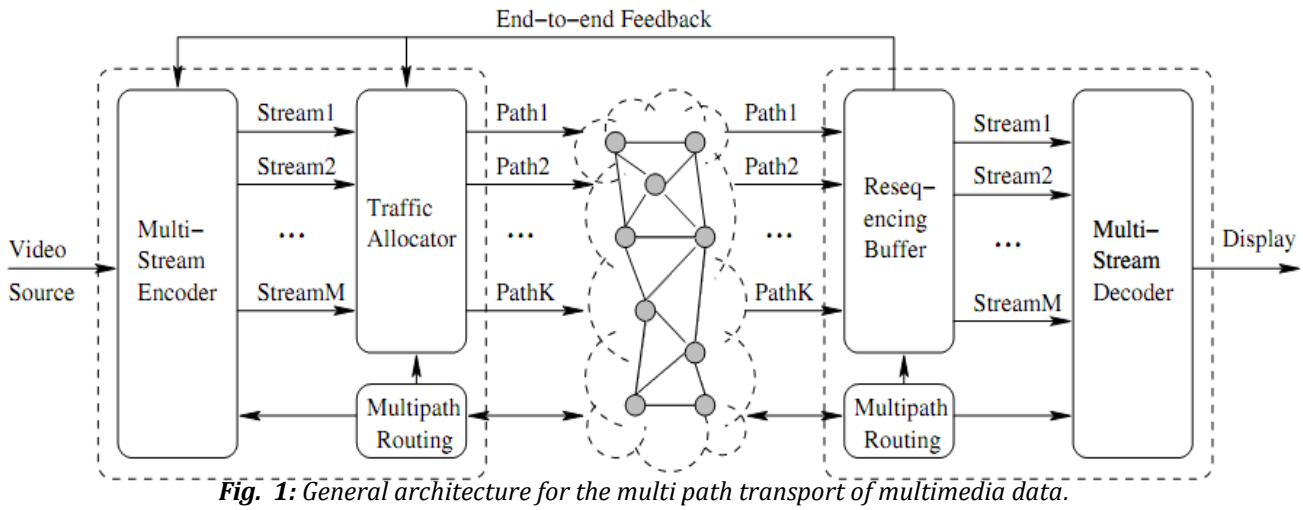

Fig. 1: *General architecture for the multi path transport of multimedia data.*

III. ROUTING PROTOCOLS:

A. Dynamic Source Routing (DSR):

DSR is fully reactive routing protocol. By reactive routing protocol we mean that it initiates a route only when it has a packet to send. It uses two basic contrivances while transmission of data i.e. route discovery and route maintenance. Every node maintains a route cache of previously learned routes. DSR supports unidirectional links since the route reply is sent back to the source based on a route in replier's cache or it is piggybacked on a route request packet for the initiator. The main feature of DSR protocol is that it possesses low network overhead [9].

***a. Route Discovery*:** Route discovery is initiated when a node needs to find a route to the destination. The source nodes initiates the route discovery by searching its route cache of previously learned routes. If no route is found, a route request packet (RREQ message) is broadcasted. When an intermediate node receives this RREQ message it searches its own route cache where all previously used routes are stored. If requested route is not found in the cache, the node broadcasts the packet forward after having added its address to the message header. However a node returns a route reply (RREP) message to the initiator, if it is the target of the request or a node knowing a valid route to the destination.

***b. Route Maintenance*:** For the maintenance of routes, in DSR a node sends HELLO messages periodically to its neighbouring nodes. If a node fails to receive three consecutive HELLO messages from a neighbour, it finalizes the link failure to the particular node. A node on detecting a link rupture, sends a route error (RERR) message in upstream direction. Once the source node receives this RERR message it reinitiates the route discovery process [9].

B. Ad hoc on-demand Multipath Distance Vector Routing (AOMDV):

AOMDV extends AODV for providing multi paths hence shares quite a lot of characteristics with AODV. The main difference lies in route discovery procedure. The RREQ and RREP messages in AOMDV use alternate paths from source to destination. AOMDV ensures that the multi paths discovered are loop free and disjoint.

AOMDV was designed essentially for highly dynamic networks where link failures and route breaks take place habitually. It uses three types of control messages RREQ (route request), RREP (route reply), and RERR (route error) for route maintenance. A node broadcasts RREQ message throughout the network whenever it needs a path to send data. When a node receives a RREQ message it checks the destination address field of RREQ. If the node possesses any information regarding the destination or itself is the destination, it transmits the RREP message back to origin node. Otherwise if an intermediate node does not contain any information regarding the route to destination or if it is not the destination, RREP packet is sent back to the source node. AOMDV services hop count field in its routing table for several route entries. For identifying next multiple hops it uses hop lists available in the routing table [10]. AOMDV provides the multi path with following desired characteristics:

a. Loop freedom: AODV route update rules limit a node to have at most one path to destination. Hence, modifications in this protocol are needed to have more than one path to destination. However, these modifications must be done in such a manner that loop freedom is not compromised. Accepting a longer path after having advertised a shorter path to neighbours by a node may cause routing loop.

b. Disjoint paths: Disjoint paths are a natural choice for selecting an effective subset of alternate paths from a potentially large set, because the probability of their correlated and simultaneous failure is much less as compared to overlapping path set. Disjoint set of paths between a pair of nodes have no common links. These disjoint paths are discovered by AOMDV with the dynamics of its route discovery procedure.

IV. PERFORMANCE EVALUATION AND COMPARISON

The objective of this paper is the performance evaluation of two multipath routing protocols for mobile ad hoc networks using NS2 simulation tool. NS2 is discrete event simulator for network research [11]. It provides substantial support to simulate bunch of existing protocols. Besides this new protocols to be implemented are also simulated in NS2. We conduct the simulation of the developed system using NS2 version 2.34. The simulation is carried out in Linux operating system. Simulation overview is depicted by the following **Figure: 2.**

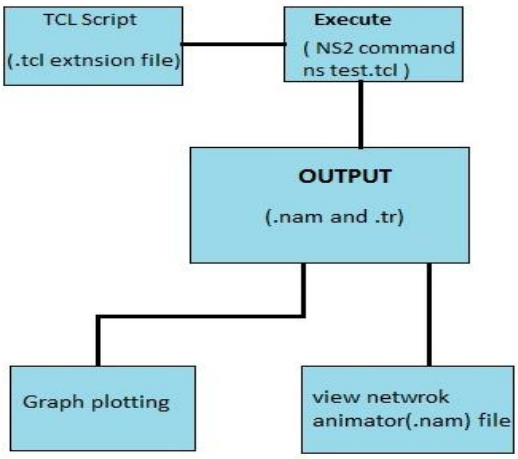

Fig. 2: Simulation Overview

The simulation environment (Parameters) is defined as below (Table 1).

Parameter	Value
Simulator	*NS2 version 2.34*
Channel type	*Channel/Wireless Channel*
Radio propagation model	*Propagation/TwoRayGround*
Network interface type	*Phy/WirelessPhy*

MAC type	*MAC/802_11*
Interface queue type	*Queue/Drop Tail*
Link layer type	*LL*
Antenna	*Antenna/ Omni Antenna*
Max. packet in ifq	*100*
Simulation area(m*m)	*500*500*
Number of nodes (mobile)	*20*
Source type	*TCP*
Simulation Time	*150s*
Routing protocols	*AOMDV/DSR*

While simulating the video transmission over the network developed in NS2, we have considered following three key performance metrics to be evaluated:

a. End-to-end Delay: Delay is calculated when a specific packet is transmitted from source to destination node as the difference between send times and received times. Delays due to route discovery, queuing, propagation and transfer time are included in the delay metric [12]. The end-to-end delay or network delay indicates how long it took for a packet successfully delivered from the video or cbr source to reach to the application layer of destination. It represents the average delay in the network and is usually in seconds or fractions of seconds.

Figure 3 shows the delay of AOMDV and DSR. It is high in terms of AOMDV while transmitting video data because of high traffic over channels and inadequate load balancing. Node 1 represents the video data over multi paths however Node 2,3 and 4 are transmitting normal cbr traffic at the same moment.

***b. Throughput*:** Throughput is the number of packet that is passing through the channel in a particular unit of time. This performance metric show the total number of packets that have been successfully delivered from source node to destination node and it can be improved with increasing node density. In simple words throughput is the rate of successful packet delivery over a channel.

The throughput comparison of the said protocols is illustrated by figure 4, which clearly indicates the higher throughput of DSR as compared to AOMDV while considering video data transmitted by Node 1.

c. Packet loss: The packet loss is specified by the packet delivery ratio. It is the total number of packets gone during the simulation. It is calculated as :

Packet Loss= Number of Packets Sent – Number of packets received.

The lower the packet loss is, the more complete and correct is the protocol.

Since we are dealing with video transmission which is done by Node 1, figure 5 clearly shows the higher packet loss in AOMDV because of its higher delays as well as more congestion on its paths.

The parameters are investigated also while increasing the number of nodes in the network, but the protocols response are varying in a same fashion.

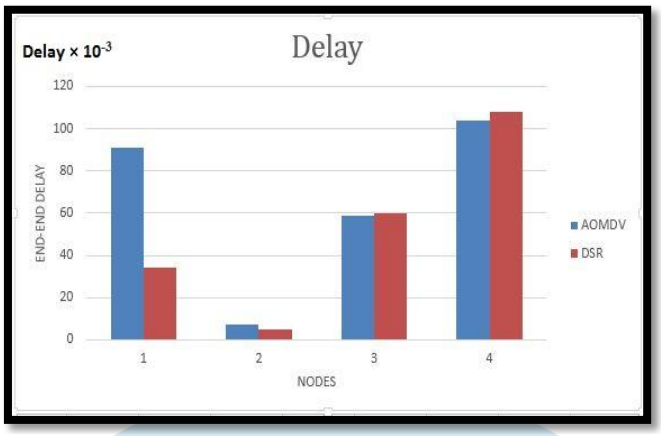

Fig.: 3 Comparison of Delay between AOMDV and DSR

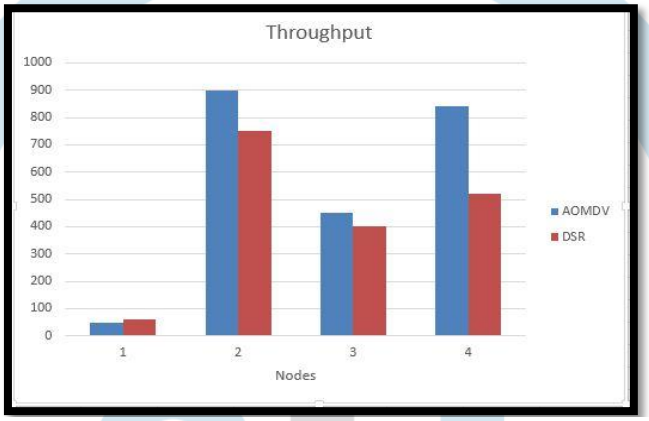

Fig. 4: Throughput

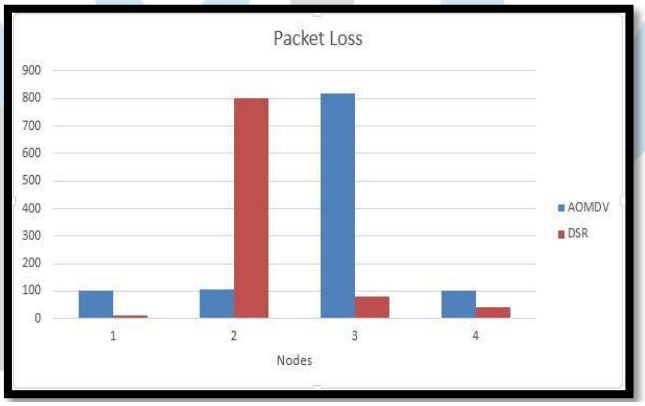

Fig. 5: Packet loss

V. CONCLUSION

For studding the performance of multipath routing protocols AOMDV and DSR based on some key performance metrics, a tcl file is created using NS2 network simulator. The jurasic park video trace file is transmitted from source to destination for analysing the behaviour of protocols for multimedia transmission purposes. The tcl file is executed using NS2 command and resultant trace files (.nam and .tr) are acquired. After executing tcl script the .tr file is observed and X-graphs are generated. Simultaneously the .nam file is executed for visualising the packet movements between the nodes. The different QoS parameters are simulated and analysed using X-graphs. Finally the comparison of the two protocols is shown by graphs while considering the both video as well as cbr traffic. The results evidently show that the DSR protocol provide better results while transmitting video data because of its proper load balancing and low network overhead .

ACKNOWLEDGEMENT

In the name of Allah, whose love made this work possible. Peace and blessings be upon the Prophet Muhammad ﷺ, the beacon of true light and mercy for the worlds. I am deeply grateful to my friend Towseef for being a part of this challenging project, to my teachers Dr. Sajad Ahmed Lone and Ms. Saima Maqbool for persistent support and guidance, to my Abu and Ami for their

prayers and softness, to the hundreds and thousands of kind souls around me and most importantly to Bariya for unconditional support..

All praise to Allah.
ALHAMDULILLAH.

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