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Performance Evaluation of Ad hoc On-Demand Distance Vector Routing Protocol under Video Streaming

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***Abstract*—Video streaming becomes an essential requirements in everyday life. It has been received a great attention from industry and researchers for better human life. To achieve of users demands, an efficient networks protocols should be used. The most popular networks is Mobile Ad hoc Networks. It is a form of movable non-wire networks that a self-configured and self-organized network. The routings are the core of component that sends data from sources to destinations though wireless nodes. This paper investigates the performance of Ad hoc On-Demand Distance Vector (AODV) Routing Protocol under video traffic over PHY IEEE 802.11g. A different scenarios of video streaming were used. The metric in terms of throughput, end to end delay, packet delivery ratio and routing overhead were measured.**

***Keywords:* MANETs, Performance evaluation, Video Streaming, AODV**

I. INTRODUCTION

Mobile ad hoc networks (MANETs) become popular and gain a great deal of importance from both of the researchers and industry [1]. The MANET is a group of wireless mobile nodes (Mobile phone, laptop, PDA, MP3 player and etc...) which can act as a transmitter, router or receiver. MANET is a peer-to-peer communication technique arises when a group of mobile nodes (MNs) can performed a communications through multi-hop routing using the multi-hop wireless link without centralized administration. MANET is homogeneous when the mobile nodes (MNs) are similar structure, platforms and equal capabilities and responsibilities to perform, and heterogeneous when otherwise. In MANETs nodes that are free in moving in and out in the network, any new node can join the network at any time anywhere, likewise any node can leave the network. MANETs have promising features such as topological flexibility, fast deployment, mobility, robustness, fault resilience, self healing and independence of fixed infrastructure spark off [2][3]. However, routing protocols establishes the governing rules and spiffy the set of parameters that indicate how the data information are exchanged between different nodes in networks[2]. Recently, researchers proposed many routing protocols algorithms to overcome the challenges of MANETs and to solve the facing problems such as failure due to node mobility, limited power on mobile nodes, topology changes, limited bandwidth, link, power consumption, etc. This paper investigates the performance of Ad hoc On-Demand Distance Vector (AODV) Routing Protocol under Video Streaming.

II. VIDEO TRANSMISSION TECHNIQUES OVER MANETS

Due to the demand of users, video streaming must be made possible as the satisfaction of receivers in real-time in Mobile Ad hoc Networks. Changes in topology, Mobility of nodes, life of battery, security threats and protocols affect the performance of MANET. To provide efficient QoS in MANET, there is a solid need to investigate and identify the effect of number of mobile nodes, the network size and mobility speed on QoS [4]. The Video transmission techniques over MANETs can be classified into three main techniques; Coding techniques, Layering techniques and Routing techniques as shown in Figure 1.

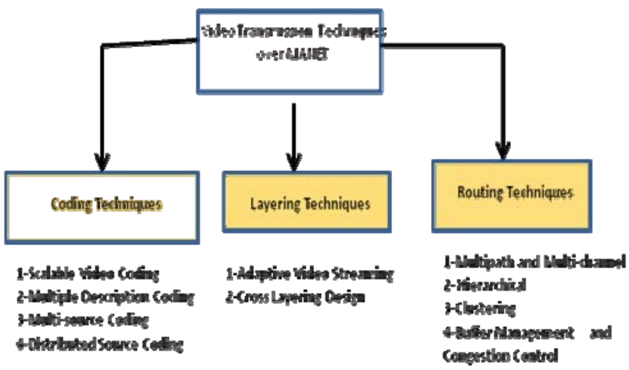

Figure 1. Video transmission techniques over MANETs

However, Video streaming in real time requires special techniques that can overcome the losses of packets in the unreliable networks

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III. AD HOC ON DEMAND DISTANCE VECTOR (AODV)

AODV is a reactive routing protocol designed for MANETs networks. It is proposed by Charles Perkins and Elizabeth Royer in 1999 [5]. AODV is an on-demand routing protocol developed with the combination on the DSDV and DSR algorithm, it establishes routes between nodes only as needed by source nodes. AODV need not a routing table, it maintains their routes as long as they are needed by the sources. According to their structure, AODV forms trees edges which support it to connect multicast group of mobile nodes (MN). These trees are composed of the group of (MN) and the intermediate nodes required to connecting the (MN) as a group of members. AODV protocol has important advantages, a) uses sequence numbers to ensure the freshness of links ; b) guarantee loop-free, self-starting, and c) supported scalability to large numbers of mobile nodes. AODV uses flooding in order to find the paths requested by a sender node, for this purpose AODV uses route request message RREQ flooded through the entire network, where the RREQ have the current sequence number for the sink node of which the sender node is aware and from then any received node a RREQ should acknowledge to it using a RREP message only if it has a route to the required sink node [5].

IV. RELATED WORK

Many works have been done in the area of routing protocols in MANETs. Different protocols had been evaluated using a different kind of simulators such as NS-2, OPNET, OMnet++ and other simulation tools. The performance evaluation performed to investigate the feasibility, reliability and the quality of service (QoS). The following paragraph showed the state of art and most important studies done recently: Hazzaa et al.(2017) [6] evaluated the performance of AODV for multimedia traffics (FTP, Voice, Video Conference) in terms of delay , throughput , network load , retransmission attempts as QoS parameters for MANET network , and they used route discovery time , routing traffic received, routing traffic sent as QoS parameters for the AODV protocol. Their simulation works implemented in the environment of OPNET modular and show that there are significant differences between the three types of multimedia traffics .They conclude that the impact of traffic type on MANET depend on the QoS requirements for each type of traffics.

V. PERFORMANCE EVALUATION PARAMETERS

A. Average Packet - End-to-end delay(E2E)

End-to-end delay or sometimes called one-way delay (OWD) of a network is defined as how much time taken by the network to sent information data with a unique ID from source to destination (successful packet transmission). E2E delay (D_{E2E}) includes all possible delays in the network such as (route discovery latency, queuing delay at the interface queue, retransmission delay by the MAC , processing delay , propagation delay, MAC control overhead and intermediate nodes delay) as shown in Eq.(2).

To calculate the average E2E delay ($AV_{(E2E)}$) the possible delays were added for each information data packet sent successfully i and divided the accumulative sum by the number of received information data packets (N) as in Eq.(3). A routing protocol with minimum delay represents the reliability of a network. In fact, E2E is important criteria for multimedia applications.

$$D_{E2E_i} = [D_{RDD_i} + D_{queue_i} + D_{RTD_i} + D_{proc_i} + D_{prop_i} + D_{trans_i}] = (R_i - S_i) \quad (1)$$

$$AV_{(E2E)} = \frac{1}{N}\sum_{i=1}^{n}(R_i - S_i) \quad (2)$$

Where :

D_{RDD_i} : Route Discovery Delay

D_{queue_i} : Queuing delay

D_{RTD_i} : Retransmission delays at the MAC layer

D_{proc_i} : Processing delay

D_{prop_i} : Propagation delay

D_{trans_i} : Transmission delay

N : The number of d = succrssfully received packets

R_i : Is time at which a packet with unique id i is received

S_i : Is time at which a packet with unique id i is sent

B. Packets Delay Variation (jitter (sec))

Jitter is the variation in time between arrivals of packets. The difference in end-to-end one-way delay between selected packets in a flow with any lost packets being ignored. However, low jitter is especially important metric for real-time

C. Packet Delivery Ratio (PDR)

It is an important metric in networks, it is defined as the ratio between all the received information packets at the sink node and the number of data information packets sent by all the sources nodes. For multimedia application is desired high.

$$PDR = \frac{(\text{ Data information Packets Received at sink node })}{(\text{ Data Information Packets sent by source node})} * 100$$

D. WLAN-E2E-Delay (E2ED)

It is determined the average time that packets require from the source to the application layer at the destination node. It is expressed in seconds.

E. Throughput (bits/sec)

In MANETs throughput is considered as an important parameter to measure the robustness of the network.

$$\text{Throughput} = \frac{(\text{No of Bytes Received} * 8)}{(\text{Simulation Time} * 1000)} \text{ kbps}$$

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F. WLAN Load

It is the total load (in bits/sec) send through wireless LAN layers by all higher layers in all WLAN nodes of the network.

G. Total packets dropped

This metric is important for video streaming applications because they are sensitive for packets dropped or loss which can affect quality of video.

PD= Total Packets Sent –Total Packets Received

I. Routing Overhead

It is the number of all routing control packets (traffic sent (pkts/s)) that every node sends in order to get the knowledge of the network and establish paths. This metric used to measure the efficiency of the routing protocol. Proactive protocols because they are use routing tables they are planned to send a higher number of control packets than reactive ones. If the number of routing controls packets is bigger lead to the low efficient routing protocol.

$$\text{Routing overhead} = \frac{\text{Total Routing Packets Sent}}{\text{Total Data Packets Received}}$$

VI. SIMULATION SETUP

OPNET 17.5 modular is used for to analysis and test the performance of comparative routing protocol AODV. The parameters considered in this scenario are shown in Table 1.

Table .1 Simulations Parameters

Parameter	Value
WLAN Network simulation Parameters	
Network Area(Size) (m2)	**SZ** 500x500 **MZ** 1000x1000 **LZ** 1500x1500
Wireless Nodes	**LD** (5 ,10,15,20 ,25,30,35) **MD** (40,50,60,70) **HD** (80,90,100)
Node Speed (m/s)	[0 , 10] and [10,25]
MAC Layer Protocol	PHY IEEE 802.11g
Data Rate (Mbps)	54
Channel Settings	Auto Assigned
Buffer Size (bits)	256000=32 KB
Transmit Power (Watt)	0.005
Packet Reception Power Threshold(dBm)	-95
Link Delay Threshold (sec)	0.1
MANETs routing Protocols	AODV
Simulation Time(sec)	800
Addressing Mode	IPv4
Simulator	OPNET 14.5

Table 2 **Mobility Model Parameters**

Parameter	**Value**
Mobility Model (Random Waypoint Parameters)	
x_max (meters)	500
y_max (meters)	500
Speed (meters/seconds)	uniform_int (0, 10) for low mobility and, uniform(10,25) for high mobility
Pause Time (seconds)	constant (100) for low mobility and constant(0) for high mobility
Start Time (seconds)	constant (100)
Stop Time(seconds)	End of Simulation

Table 3 **MANETs Traffic generation parameters**

Parameter	**Value**
MANET Traffic Generation Parameters	
Time in seconds	100
Inter-arrival Time Packet (sec)	Exponential -01
Packet Size in bits	Exponential -1024
Destination IP Address	Random
Stop Time in seconds	End of Simulation

Table 4 **Video Traffic parameters**

Parameter	**Value**
Application Parameters	
Application	Video conferencing
Frame Size Information (bytes)	128X240 pixels
Type of Service	Best effort(0)
Application Segment Size	64.000 or 32.000
Frame Size	256
Maximum available bandwidth (MHz)	10

Table 5 **AODV Protocol Parameter**

Parameter	Value
Active Route Timeout (sec)	3
Hello Interval(sec)	uniform (1, 1.1)
Allowed Hello Loss(sec)	2
Net Diameter	35
Node Traversal Time(sec)	0.04
Route Request Retries	5
Route Request Rate Limit (pkts/sec)	10
Route Error Rate Limit (pkts/sec)	10
Timeout Buffer(sec)	2

VII. RESULTS AND DISCUSSIONS

The performance of the routing protocol AODV was evaluated using *Video Conferencing with low mobility and small scale*. In this scenario, the routing protocol under IEEE 802.11g for video streaming traffic using node density 5, 10, 15, 20, 25, 30, 35 with mobility speed in the interval [0,10] m/s and network size 100x100 m2 with the addition of other parameters described in the previous tables. We evaluated the performance in terms of the E2E delay in seconds, throughput (bits/sec), Packet Delivery Ratio, Routing Overhead. Figure 2 shows the calculated average E2E delay of each transmitted data packets during the simulation time as a function of node density. E2E delay includes all possible delays as we mentioned before in Eq (1) and Eq(2).

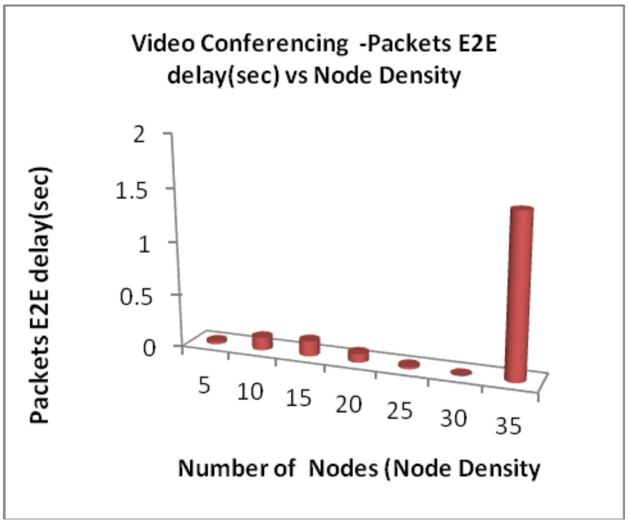

Figure 2 Packets E2E delay(sec) vs Node Density

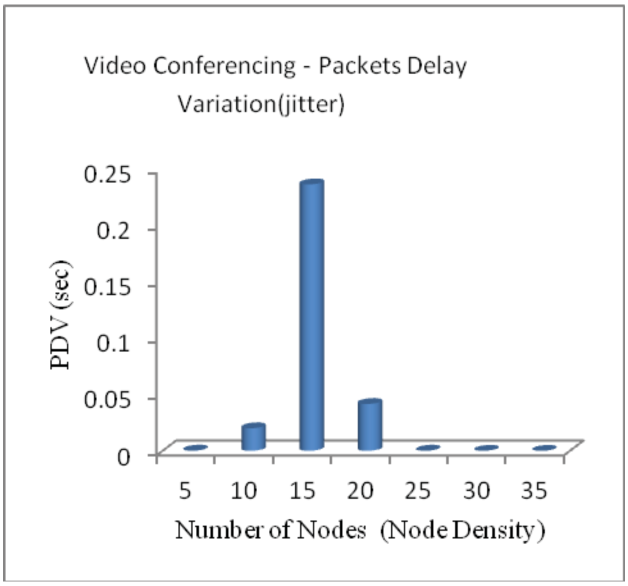

Figure 3 Packets Delay Variation(jitter)

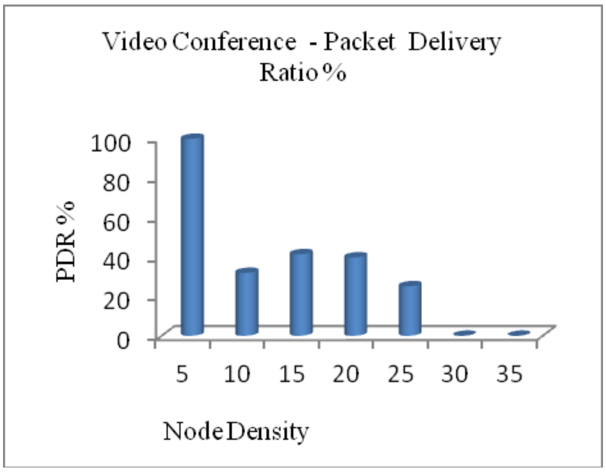

Figure 4 Packet Delivery Ratio %

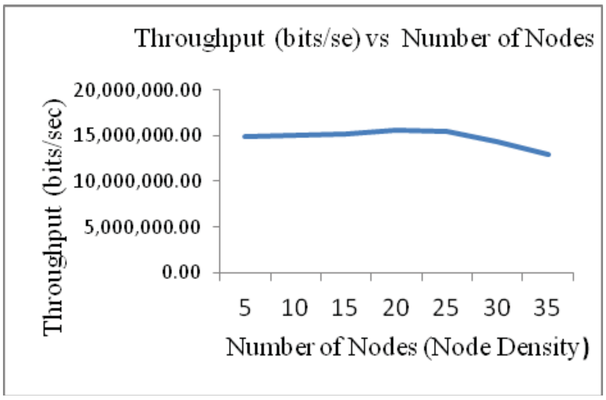

Figure 5 Throughput (bits/se) vs Number of Nodes

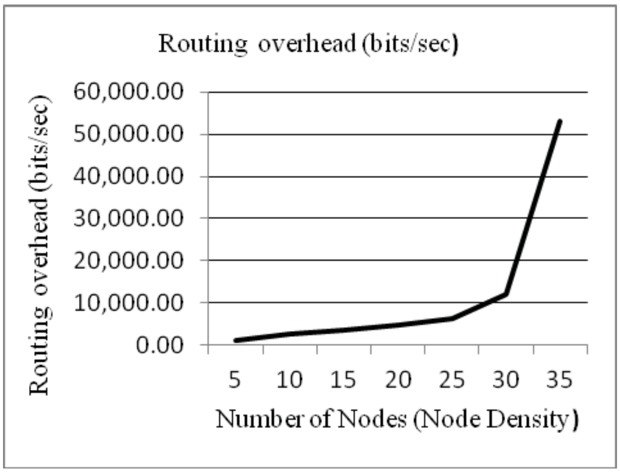

Figure 6 Routing overhead (bits/sec)

From figures 2 till 6 shows the performance as tabled below. Where AODV protocol very good in Throughput and Acceptable in Packet E2E, C Packet Delay Variation

(Jitter), WLAN-End-to-End Delay, Retransmission Attempts(packets, Network Load and Network Load. However, AODV protocol not good in Packet Delivery Ratio and Total Packets Dropped.

Protocol Metric	AODV
1-V.C. Packet E2E delay (msec)	Low
2-V.C Packet Delay Variation (Jitter)	Low
3-Packet Delivery Ratio (PDR %)	V. Low
4- WLAN-End-to-End Delay (sec)	Low
5- Throughput (bits/sec)	V. High
6-Retransmission Attempts(packets)	Less
7-Network Load (bits/sec)	Low
8-Total Packets Dropped (packets)	
9- Network Load (packets/sec)	Low

VIII. CONCLUSION

MANETs networks have received increasing research attention in recent years. There are various active research works in MANETs focuses on the enhancements of routing protocols. In this paper, we demonstrated a comprehensive performance evaluation of an enhanced MANETs routing protocols (AODV). The performance evaluation calculated in terms of various performance parameters such as average E2E-dealay, throughput, routing overhead, packet dropped, packet delivery ratio, retransmission attempts, and network load. We used in this study Video Conferencing to investigate the overall performance of the mentioned routing protocol for video streaming over MANETs. The scenario represents (small scale/low mobility density), in this scenario, the retransmission attempts, where in terms of throughput AODV is the better one.

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