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Research Article

Enhancing Quality of Service of Video Streaming Applications Over Vehicular Ad-Hoc Networks

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Abstract: Vehicular ad-hoc networks play quite an important role in communication as it is challenging to have communication across VANET nodes because of high mobility. Video streaming applications over ad-hoc networks are quite difficult because of more mobility of VANET nodes. There are various existing techniques to optimize or improve the video dissemination over ad-hoc networks. Video streaming applications need a goodquality of service in ad-hoc networks for better streaming. To optimize the performance of video streaming applications over Vehicular ad-hoc networks, a hybrid routing protocol, which is an advancement of existing routing protocol namely, AODV is proposed. It has shown better performance in terms of Peak Signal to Noise Ratio for video streaming simulated as VBR, CBR and VOIP traffic has been analyzed. This paper compares performance metrics on AODV routing protocol and proposed R-AODV where predicted lifetime metric is used as a crucial factor for route stability. The simulation and test results show that there is an articulate improvement observed in terms of application layer metrics and network layer metrics. Results show that there is a lesser number of link failures and RERR messages generated. PSNR gains have also been evaluated. The advantage of this technique is that it has got no overhead as the information retrieved is based on the RERR messages itself.

Keywords: VANETs, AODV, DSR, PBR, VOIP, DYMO, LAR

Introduction

Transmitting Video is playing important role in wireless ad hoc networks due to the wide deployment of ad hoc networks in various applications like recovery application in defense. Due to lack of centralized infrastructure, it is difficult to manage resources in an ad hoc network due to changing topology and high speed of vehicles. There are various techniques available for video transmission over vehicular ad hoc networks such as Multiple Description Video Coding (MDVC) by Gogate *et al.* (2022) along with path diversity by Apostolopoulos *et al.* (2001), to adopt the network conditions and video characteristics adaptive mode selection is proposed. Different traffic patterns can be used for transmitting Video streaming applications. One of the technique for transmission can be Variable Bit Rate (VBR) traffic since the video is composed of various frames which have a varying size so it is preferred to sent video traffic by VBR. The bandwidth utilization is low as the bit rate of video traffic is quite low. Hence VBR traffic is preferred for video streaming applications. Another method can be sending VOIP traffic over vehicular network nodes and Constant Bit Rate (CBR) traffic. Constant Bit Rate encoding is required in the scenarios where available bandwidth is constant throughout and will not be varying. Although, CBR and VBR traffic models can be easily used to simulate multimedia applications VBR encoding helps us to gain more throughput for the scenarios where bandwidth keeps varying. Definitely, bandwidth can be saved by using CBR encoding for static scenes and VBR encoding for scenes having more motion activities. The multiple sources being there implies that if one source fails during the streaming process, another can continue the transmission process. In a VANET scenario, a sourcenode could easily fail if a vehicle node goes out of the range while traveling with a certain velocity. Multiple sources are also required if the video stream is divided into different streams in order to explore path diversity within the VANETs using Multiple Description Coding (MDC). In MDC, any single media stream is fragmented into n streams which are called as descriptions. The packets of each of the description are transmitted over multiple disjoint paths. In contrast, in layered video coding (An & Nguyen, 2006), the base layer must be received as without base layer, enhancement layers cannot be utilized.

Perceptual Evaluation of Video Quality (PVEQ) is defined as a standardized end to end measurement algorithm to score the picture quality of a video application by means of a 5-point Mean Opinion Score (MOS) by De Bonet & Sullivan (2003). The measurement algorithm can be applied to analyze visible artifacts caused by a digital video encoding/decoding a process or IP based transmission networks and end-user devices. In this study, we are going to address problems related to the failure of routes during data transmission which in turn increases packet loss ratio, reduces throughput, average delay and jitter are reduced. Hence, improvement of performance of video streaming applications is seen clearly indicating the optimization of video applications over adhoc networks by new proposed protocol R-AODV.

Chen *et al.* (2004) in his studies analyzed requirements of different applications in terms of delay, jitter, bandwidth requirement, response time, Data rate, Loss/Error Rate. Various studies have been done regarding resource requirements of network applications. Related work has also been done by Kwok (1997). Some results are taken from [www.ciscopress.com/article] regarding BW, delay and jitter in streaming, VOIP, Interactive video etc.

Continuous streaming applications can cope with QoS which is significantly lower than real-time streaming applications.

Video transmission can be Constant Bit Rate (CBR) or Variable Bit Rate (VBR) channel. ISDN or DTV are supported by CBR and some applications like DVD storage over shared packets network are supported by VBR by Apostolopoulo *et al.* (2002). A video sequence has time-varying complexity. Video can be transmitted as file download but since it is a large file, it might take time. Another way can be streaming video in parts and transmit parts in succession and enable decoding at receivers' end along with playing the contents. Video streaming helps delivery and playback of the video simultaneously. The length of the delay is given by the time duration of a pre-roll buffer by Qadri *et al.* (2010).

Video streaming over adhoc networks is quite challenging as it is difficult to design a better system to deliver high performance of video over the web when there is uncertain bandwidth resulting in delay, jitter and loss rate.

Our motive is to make a routing protocol which provides better Quality of Service (QoS) for video streaming applications especially in VANET scenarios due to high mobility.Thesource node cannot detect the changes in the availability of resources and is not able to do the required adaptation to meet specific resource requirements due to high node movement resulting in route failures.Quality of Service (QoS) is required by many applications for achieving the optimum performance of applications. Various image compression techniques like MPEG-4, H.263 and multiple description coding are designed to meet various channel scenarios. This study will help in the simulation of a new proposed routing protocol R-AODV for CBR, VBR and VOIP traffic in contextto videostreaming applications and focus on comparative analysis of AODV and R-AODV.

Related Work

VANETs give various benefits to video streaming in ad hoc networks. The battery has not been a problem if built-in transceivers are used, meaning that huge buffers will serve to absorb any delay arising from multi-hop routing.There are three source coding schemes for emergency video streaming with one scheme applied in two different schemes.. Even and odd frames are sent in two different streams Wang *et al.* (2005). The Third scheme is Flexible Macroblock Ordering (FMO) with checkerboard FMO pattern for single path video stream transfer as an alternative to multiple path methods by Wenger (2003). A macroblock is a basic unit of block-based motion compensation, whereby only the difference between a block in the current frame and a matching area in the reference frame is encoded by Qadri *et al.* (2009). The possibility of video communication between two vehicles with IEEE 802.11 b transceivers in a live setting was determined. The speeds between the two nodes on an average 15mph in a city setting, it was reported that “link availability” was 97.78% by Quang Pham *et al.* (2014). In one study Soldo *et al.* (2011) title “QoE aware routing mechanism for video streaming over VANETs", routing mechanism for VANETs has been proposed which combines QoEand OLSR. The performance has been evaluated on the basis of Mean Opinion Score (MOS) value.

In the work done by Soldo *et al.* (2011), a fully distributed solution has been proposed called as Streaming Urban Video (SUV) which efficiently disseminates video to all vehicles in a city VANET as VANETs poorly supports streaming media traffic due to less bandwidth, transitory connectivity.

In Vineeth & Guruprasad (2015) performance analysis of network coded video streams in 2015 network coding technique is used to improve the quality of streaming by focusing on delay and jitter parameters in VANETs by simulation study done on different mobility scenarios. In a research work done by Sofra *et al.* (2011), a link lifetime related metric has been introduced for which link can be used for communication. This metric will help in better route construction. Link residual time is utilized here in this method to estimate the route construction. One of routing mechanism known as CBAODV (Arulkumar & George Dharma Prakash Raj, 2015) has been proposed which works on the fact that in case of failure, sender has to reuse the discovery mechanism to find a route to the destination to deliver messages whereas in An on demand multi path distance vector routing protocol

AOMDV (Marina & Das, 2002), multiple loop-ree paths and link disjoint paths have been established.

Several automotive companies, research institutions and Government organizations are involved actively in evaluating, proposing, creating and engineering futures VANET systems which will come from synergies of interconnected vehicles and infrastructures (Cunha *et al.*, 2016).

Network architectures, signal propagation, mobility modeling , routing protocols and network security are discussed in detail in this study Rehman *et al.* (2013). An efficient and robust system is the one where design parameters like QoS, minimum latency, low BER and high PDR are satisfied.

Detailed comparison of each and every routing protocols in VANET have been discussed and summarized in this study giving us a glimpse of suitability of routing protocol according to the situation. Liu *et al.* (2016) Different position based routing protocols have been discussed here with their pros and cons.

One of the work by Al-Sultan *et al.* (2014) has done a detailed survey of resource management strategies for virtualized data centres. Fundamental control loops have been taken into consideration which are there to use and manage resources in data centres.

Motivation

Routing protocols have drawn much attention from the beginning of VANET research. Previous work focused on finding feasible routes without considering predicted lifetimes of links or QoS. Few of the approaches have worked in this direction and used in the general context of mobile ad hoc networks, but lesser for vehicular ad hoc networks by Tso *et al.* (2016). Link lifetime has been taken into consideration for improving the connectivity of route so as to better performance of network applications over VANETs. Different approaches have been found in the literature to enhance the performance of ad hoc distance vector routing protocol. Less work has been found in literature keeping in view of link lifetimes of routes considered for AODV.

Ad hoc on Demand Distance Vector (AODV) routing protocol is one of the widely used table-based and reactive routing protocols (Namboodiri & Lixin Gao, 2007). AODV works on the principle that source node will send an RREQ (Route request) packet when it needs a route to a destination. Every node in AODV will forward route request messages (RREQ) further until it reaches a destination. Finally, when the destination node is found, route reply message will start traversing along the path taken by route request messages (RREQ) to reach the destination. The destination node responds to the first RREQ packet it receives by sending an RREP to the neighbor from which it received the RREQ packet. RREP packets are forwarded to other nodes until the source node is reached as per their own routing tables. Forward path is made in this manner while traversing RREP messages. It is pertinent to mention here that 'Hello' messages are used by nodes to probe their neighbors while validating routes. "Hello" messages are sent at regular intervals of time. The Problem to address here is to optimize the performance of video streaming applications in the vehicular ad hoc network by using the hybrid routing protocol, in turn, improves packet delivery ratio thereby reducing delay, jitter and packet loss ratio.reducing error messages .One of the studies has given Distance Progress Opportunistic Routing (DPOR) (Perkins & Royer, 1999) has proven better by providing new opportunity to forward data packets from static locations to the mobile vehicles or even between two or more vehicles. DPOR is successful in achieving higher delivery ratio and lower end to end delay in comparison to other protocols. One of the multipath routing protocol which has tried to improve lifetime by energy conserving preemptive routing protocol by proposing a cooperation of the routing layer with MAC layer power control method. Mirjazaee & Moghim, N. (2022) this Energy aware Predictive Preemptive Multipath ad hoc on Demand Distance Vector (E-PPAOMDV). This protocol focus on an energy-aware mechanism by aiming at a residual energy of nodes. It has done a comparison with AOMDV by balancing the energy consumed.

Materials and Methods

In the proposed extended routing protocol, standard AODV protocol is edited with one additional metric which is predicted a lifetime of a link. It is called as routing AODV (R-AODV).. We are going to maximize the minimum predicted the lifetime of various links forming the route. It will predict the stability of route formed from source to destination.

We assume the range of the communication of WLAN technology be R. The absolute distance between two nodes p and q are represented by $|d_{pq}|$and their corresponding velocities are v_p and v_q respectively. The lifetime of a link between nodes p and q is calculated as given in Eq. 1 in (2007):

$$Lifetime\ link = \frac{R-|\mathrm{dpq}|}{|v_p - v_q|} \quad (1)$$

v_p and v_q are respective velocities of nodes p and q.

Since a route always comprises of one or two links, the route lifetime is the minimum of all its link lifetimes i.e in Eq. (2):

$$Lifetime\ route = min\left\{Lifetime\ link\right\} \quad (2)$$

For predicting lifetime, we need to have mobility prediction mechanisms. Consider two nodes i and j within Tx range R. (x_i, y_i) and (x_j, y_j) are coordinates of i and j, vi and vj are speeds of the two nodes. The Distance between two nodes is represented as Eq. (3):

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$$Dij = \sqrt{(x_j - x_i)^2 + (y_j - y_i)^2} \quad (3)$$

Predicted time duration the two nodes will stay connected isgiven by Eq. 4:

$$D_t = \frac{-(ab+cd)+\sqrt{(a^2+c^2)r^2-(ab-bc)^2}}{(a^2+c^2)} \quad (4)$$

When directions of vehicles are considered i.e., two vehicle nodes are approaching towards each other or moving away from each other. It is given by Eq. 5 in (2007).

Where, s = 1, when vehicle nodes are heading towards each other and s = -1, when nodes are moving away from each other:

$$Lifetime\ link = \frac{\sqrt{R^2-w^2}+s.\sqrt{d_{ij}{}^2-w^2}}{v_i+v_j} \quad (5)$$

This predicted lifetime metric is sent along with each RREQ packet from source to destination. Now the link which is having minimum link lifetime is a time which is considered to be the lifetime of the route as the route will expire according to the time predicted for different links in a route. Now when destination receives the RREQ packet it will start sending RREP packets. Here in this proposed protocol, destination will not send RREP packets unless and until it matches various predicted lifetimes for different routes formed between source and destination. Route is chosen to have a value of maximum among minimum predicted lifetimes of links and destination will start sending RREP packets to the source for the route chosen where value of predicted lifetime is maximum, an approach to maximize the minimum predicted lifetime for data transmission so as to reduce route failures in turn reduce packet losses which will increase throughput of the proposed model. Here, the route is chosen only on the condition that it will expire little later than the other routes available from source to destination. In this proposed protocol, we have the benefit that only RERR messages are required for optimizing video streaming applications. It utilizes the known network parameters and information of routing messages only to get back packet loss information at the network layer and henceforth it does not cause any delay and brings in a very small reduction in coding efficiency. In this way, it is efficient technique than previous discussed techniques in literature like “DeReQ: QoS routing algorithm for multimedia communications in vehicular ad hoc networks” by Namboodiri & Lixin Gao (2007) and “Improving route stability and overhead on AODV routing protocol and making it usable for VANET” by Ali Cherif & Boukli Hacene (2022).

We need coordinates of the previous node and current node, velocities of two nodes to determine the predicted lifetime between two nodes. Location and velocity are changing frequently in VANETs due to the high speed of vehicles.

In the following figure, it has been shown that different types of video streaming traffic can be simulated by CBR, VBR and VOIP applications on VANETs. The efficacy of standard AODV has been implemented on the different traffic types. In this study, route stability is taken into consideration as stable routes will lead to better performance of video streaming applications as CBR, VBR and VOIP. For achieving improved Quality of Service (QoS), a new hybrid routing protocol is proposed where standard AODV routing protocol has been modified with a new metric i.e., predicted the lifetime of a route in turn choosing the more stable routes. Predicted lifetime has been calculated on the basis of location and velocity of nodes. The Distance between two nodes plays a very important role in calculating the lifetime of a link. Fundamentally, AODV has been incorporated with Prediction Based Routing (PBR) protocol metrics given by Namboodiri & Lixin Gao (2007).

This new hybrid routing protocol has been implemented on CBR, VBR and VOIP type applications and video streaming applications are very well simulated as CBR, VBR and VOIP where it has been observed that more robust paths are chosen by new proposed routing protocol as throughput has been increased, PDR is increased. Moreover, fewer route failures are there and Lesser Route Error (RERR) messages are generated clearly indicating the improved performance evaluation of video streaming applications as CBR, VBR and VOIP traffic types.

Analytical solution of optimization problems is to maximize the value of the lifetime of a link. Given a function

f: AR from some set of real numbers.

An element *x*0 in *A* such that *f*(*x*0)≥*f*(*x*) for all *x* in *A*.

Function f is called variously or objective function:

$$Minimizing\, f(x) = \sum a_i xi^2 + b_i xi + ci \quad (6)$$

In given Figure (1) below, it has been explained that video streaming applications can be simulated as CBR, VBR and VOIP traffic. It has been previously authenticated by Niu *et al.* (2007) in a study that AODV outperforms other routing protocols like Dynamic Source Routing (DSR) Johnson *et al.* (2007), Location Aided Routing (LAR) protocol (Sharma *et al.*, 2014) and Dynamic MANET (Johnsonet al., 2007) on Demand Routing (DYMO) protocol in VANET scenarios for CBR and VBR applications. Further, in this study, AODV has been modified as it showed better results. Different video streaming applications can be treated as constant bit rate traffic, variable bit rate traffic and Voice Over Internet Protocol (VOIP) traffic. We have analyzed video streaming as different traffic types and simulated video streaming applications with AODV routing protocol. Further, route stability is incorporated in AODV with the help of a metric known as calculated minlifetime based on the location of nodes and velocity of nodes. This calculated lifetime has been taken from Prediction Based

Routing (PBR) (Sommer & Dressler, 2007) protocol and a new hybrid protocol R-AODV is proposed which has been again implemented on CBR, VBR and VOIP traffic types. There is a clear enhancement in performance of CBR, VBR and VOIP applications in terms of packet delivery ratio, packet loss ratio. In addition to this, RERR messages have been reduced with R-AODV and link failures have also been reduced at the same time. This clearly indicates that performance of video streaming applications has been optimized.

We have implemented and evaluate our design using the Qualnet simulator for different network settings and video sequences. Simulation results have clearly shown that proposed method has achieved gains in peak signal to noise ratio up to 2.1 dB and perceptual gains in quality metrics.

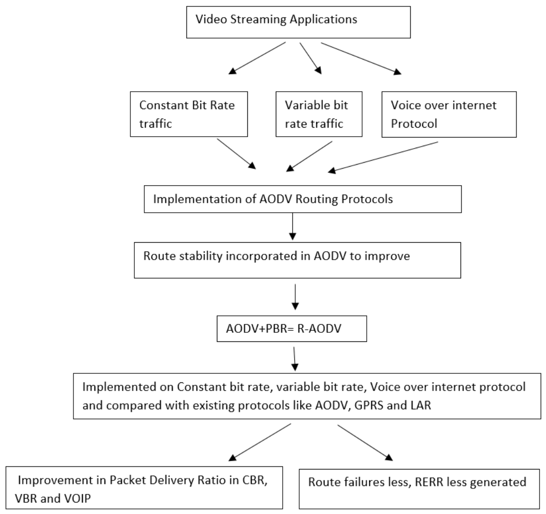

Fig. 1: Proposed system and solution

Algorithm for Proposed Routing Protocol

To check the predicted lifetimes of different routes and choosing the better route. In Route Request phase Source node initiates the route discovery process by broadcasting the RREQ packet with minimum route life time set to zero.

Each node that receives broadcasted RREQ packets does following actions. Calculates lifetime for the link between the current node and previous node. Route Discovery Process of R-AODV. If (not previously received) make route table entries along with additional field minlife time else check if the new route is better or not (in terms of minlife time) i.e., store the better route check if the current node is a destination if it is not destination RREQ is rebroadcasted with modified fields the process continues till destination is reached this forms the complete reverse path from the destination node to the originator node.

In standard AODV, Route Requests (RREQ) and Route Replies (RREP) are here represented in the network topology in Figure (2). Route Request message formats are defined as per standard which includes RREQ ID, Destination IP address, Destination sequence number, originator IP address, originator sequence number and hop count (Sharma *et al.*, 2014).

In proposed protocol, standard Route Request is modified with certain field values such as current location with the help of coordinates of a VANET node and velocity of the node. Distance is calculated using the coordinates of two nodes .Velocities of different nodes are initialized Predicted lifetime is calculated on the basis of the distance between two nodes, difference in velocities of two nodes and transmission range. RREQ messages are sent to all neighbor nodes and finally, when RREQ message reaches on the destination node, the decision is taken for choosing the path on the basis of route stability after waiting for a specified time period or till some other RREQ reaches the destination. The path is chosen on the basis of fact that the link is more stable when a lifetime of the link is comparatively more than other links.

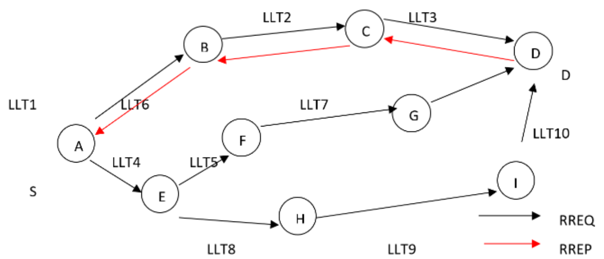

Fig. 2: RREQ messages along with link lifetimes for R-AODV

Similarly, RREQ messages in R-AODV have been represented here in Figure (4). Locations Coordinates of each of the node is sent along with RREQ message. Moreover, velocities of nodes are also sent so that predicted link lifetime is calculated for every pair of nodes. It is a minimum lifetime for which any two nodes will share a stable path. The notation used here for predicted link lifetime in this Figure (4) is LLT1, LLT2, LLT3, LLT4 and so on. For one particular path, link lifetime is the minimum of all the link lifetimes of links which are forming a path. Let us suppose LLT1 is 4, LLT2 is 2 and LLT3 are 3, in this particular scenario link lifetime of route ABCD is 2, the minimum of all the values for route links. Now, at destination node D, a comparison is made to choose a path where we have a maximum value of LLT along different paths such as ABCD, AEFGD and AEHID. For Example, let us say that respective minlife times of routes ABCD, AEFGD and AEHID be 2,4 and 3, in this case maximum value of min lifetime of path i.e., 4 for path AEFGD is chosen. Finally, the path is chosen so that it should expire little later than other available routes. It is a way to maximize the minimum values available for different paths.

In this proposed protocol, along with RREQ, predicted lifetime is sent, each node will keep on comparing the minlifetime value and store the current value if the current value is less than the previous value. RREP will be sent back to the source on the basis of finding the maxima of minimum predicted minlifetime values. On the whole, it is to select the route where predicted minlifetime is maximum. Based on the packet loss information from control messages, packet loss ratio can be reduced. Packets are marked as lost on the basis of on RERR and RREP messages (Johnson *et al.*, 2007; Ko & Vaidya, 1998). Although, routing messages is a good indicator of packet losses in the network, it is not completely accurate (Sommer & Dressler, 2007). When a RERR packet is received, the preceding packet transmitted over the broken route is lost. One RERR may indicate more than one preceding packet loss over the broken route. This is because of the delay of RERR in reaching the source node. With our proposed model, RERR messages also decrease due to less number of route failures. RERR message indicates a link failure of a route. Henceforth, this model makes sure that route stability is gained to the higher extent by which performance of video streaming applications will improve over vehicular ad hoc networks.

Results and Discussion

To analyze the behavior of new proposed routing protocol R-AODV, comparisons have been made for standard AODV, GPRS and LAR and R-AODV protocols which are implemented on CBR, VBR and VOIP traffic types showing different routing metrics such as packet delivery ratio, packet loss ratio,Route failures and RERR messages generated.Simulation has been done on Qualnet Simulator 5.0. Simulation has been done on few parameters given below in Table (1). VBR traffic has been generated by keeping inter-packet interval time of 20 ms in two packets. Simulation has been done using modified JM codec and Qualnet simulator. Wireless communication medium model is being used by Qualnet for propagating signals between nodes. A pair of source and destination is randomly chosen.

Three video sequences have been considered namely foreman, coastguard, mother and daughter which are all Common Intermediate Format (CIF) with 150 frames at the frame rate of 15 fps. For each of the network scenarios, video sequences are sent repeatedly 500 times in order to generate statistically meaningful quality measures. Apart from analyzing other metrics, PSNR has been evaluated to have clarity on improving quality of video streaming.

Table 1: Simulation parameters

Parameter	Value
Protocols	AODV,R-AODV, GPSR, LAR
Number of Nodes	30,50,60,80,90
Pause Time	30 s
Simulation time	30,100s
Traffic Type	CBR, VBR,VOIP
Transmission Range	250 m
Mobility Model	Mobility Flags for Patterns
Simulation Area	1500×1500
Node Speed	20-40 km/h
Interface Type	Queue
MAC Protocol	802.11 Ext
Packet Size	1024 bytes
Radio Propagation Model	Two Ray Ground

There are different scenarios on which simulation is performed like varying node density, the speed of the nodes, packet size and background traffic for VBR, CBR and VOIP applications. Simulation is performed for CBR,VBRand VOIP traffic to see the efficacy of new hybrid protocol R-AODV in the scenarios defined as compared to standard AODV.

Packet Delivery Ratio is calculated by the formula given in Eq. (7):

$$PDR = \frac{(Total\ packets\ received\ by\ all\ destination\ nodes)}{(Total\ packets\ sent\ by\ all\ source\ nodes)} \quad (7)$$

Packet Loss is the ratio of the number of packets that never reached the destination to the number of packets originated by the source Chen *et al.* (2004). Represented by Eq. (8) and packet loss % by Eq. (9):

$$Mathematically,\ PL = \frac{n\ sent\ packets\ \text{-}\ n\ received\ packets}{n\ sent\ packets} \quad (8)$$

$$PPL\ Ratio = \frac{n\ sent\ packets\ \text{-}\ n\ received\ packets}{n\ sent\ packets} \times 100 \quad (9)$$

Scenario 1 VBR Traffic with varying node density for AODV implemented with proposed protocol R-AODV on the application layer and network layer metrics in Table (2).

Table 2: Comparison of AODV and R-AODV for VBR traffic by varying node density

Nodes	AODV					R-AODV				
	Packet Delivery Ratio	Packet Loss%	RERR Initiated	Link Failures	RERR Received	Packet Delivery Ratio	Packet Loss%	RERR Initiated	Link Failures	RERR Received
30	0.84	14.2	1	1	1	0.9	9.5	1	1	1
60	0.88	11.3	2	3	1	0.93	4.76	0	1	0
90	0.90	9.0	1	4	1	0.95	4.67	1	1	1

In Figure 3(a-b), it has been observed that Packet delivery ratio has improved a lot with a new proposed hybrid protocol R-AODV especially when node density is increased whereas, for a small number of nodes, there is not much variation seen with new hybrid protocol R-AODV. Here in this scenario when network layer metrics are taken into consideration it is seen that link failures have decreased a lot along with less RERR messages

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generated for increasing number of nodes. Overall, our new proposed protocol R-AODV is giving better results for video streaming applications as VBR applications over VANETs by increasing throughput and decreasing link failures. This is a way to improve the performance of video streaming applications simulated as VBR applications in VANET scenario. This performance improvement has been done very well with increasing node density also.

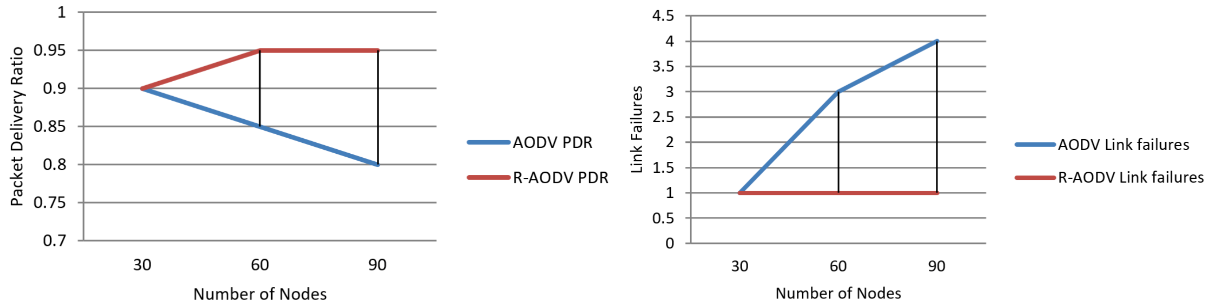
Scenario 2 CBR Traffic with varying node density for AODV implemented with proposed protocol R-AODV on the application and network layer metrics in Tables (3-4). In this simulation, a number of nodes are taken as 30, 60 and 90 for variation in node density.

Table 3: Comparison of AODV and R-ADOV for CBR traffic on varying node density

Nodes	AODV					R-AODV				
	Packet Delivery Ratio	Packet Loss%	RERR Initiated	Link Failures	RERR Received	Packet Delivery Ratio	Packet Loss%	RERR Initiated	Link Failures	RERR Received
30	0.82	16.3	7	9	6	0.93	6.94	5	5	2
60	0.87	12.6	6	11	6	0.91	8.33	4	8	14
90	0.90	11.5	5	13	8	0.91	8.33	3	8	5

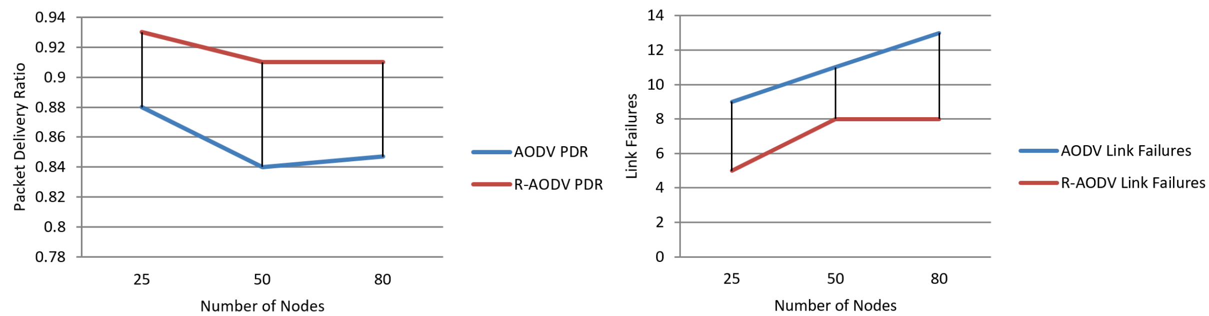
Table 4: Comparison of packet delivery ratio for GPRS and R-AODV for CBR traffic

Nodes	GPSR					R-AODV				
	Packet Delivery Ratio	Packet Loss%	RERR Initiated	Link Failures	RERR Received	Packet Delivery Ratio	Packet Loss%	RERR Initiated	Link Failures	RERR Received
30	0.85	9.5	6	1	1	0.89	8.6	2	1	1
60	0.87	5.3	5	3	1	0.9	4.23	2	1	0
90	0.9	2.1	2	4	1	0.95	3.97	1	1	1



(a) (b)

Fig. 3: (a) Comparison of packet delivery ratio for AODV and R-AODV for VBR traffic (b) Comparison of link failures for AODV and R-AODV for VBR traffic



(a) (b)

Fig. 4: (a) Comparison of Packet delivery ratio for AODV and R-AODV for CBR traffic (b) Comparison of link failures for AODV and R-AODV for CBR traffic

In this scenario from the graphs 3(a-b), it has been observed that Packet Delivery Ratio (PDR) is clearly improved with new proposed routing protocol R-AODV and simultaneously decreasing packet loss ratio. Link failures have decreased a lot when compared with standard AODV and consequently lesser generated RERR messages with R-AODV. Therefore, it is useful for optimizing the video streaming applications on VANETs as CBR applications.

In Table (5), our proposed R-AODV algorithm has been compared with Greedy perimeter stateless routing

(GPSR) (Liao & Gibson, 2009; Liao & Gibson, 2011) as both of these protocols are more closely related to the position of nodes. GPRS is a novel routing approach which uses the position of routers and packets destination to make packet forwarding decision. Two crucial factors which play important role in GPRS are rate of change of topology and number of routers in the domain.

Scenario 3 VOIP traffic with varying Node density for R-AODV and AODV for network layer and application layer metrics in Table (5)

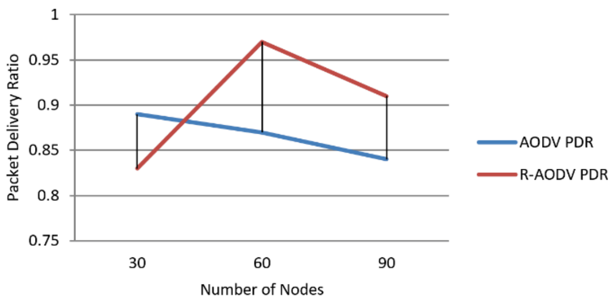
In Table (6), simulation parameters for VOIP traffic have been considered for evaluation performance comparison for AODV and R-AODV by varying the node density. The articulate information can be drawn from Figure 5(a-b) which shows that there are lesser number of failures with R-AODV as compared to the AODV. When there is increase in number of nodes, link failures are increasing comparatively.

Table 5: Simulation Parameters for VOIP traffic

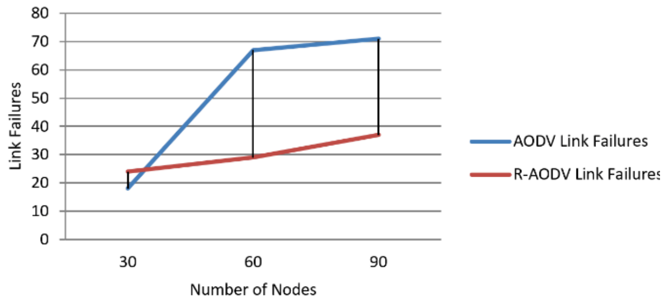
Parameter	Value
Protocols	AODV,R-AODV
Number of Nodes	30,60,90
Pause Time	30s
Simulation time	100s
Traffic Type	VOIP
Transmission Range	1000 m
Mobility Model	Mobility Flags for pattern
Simulation Area	1500mx1500m
Node Speed	20-40 mps
Interface Type	Queue
MAC Protocol	802.11 Ext
Packet Size	512 bytes
Radio Propagation Model	Two Ray Ground

Table 6: Comparison of AODV and R-AODV for VOIP traffic by varying node density

Nodes	AODV						R-AODV					
	Packet Delivery Ratio	Max MOS	Min MOS	RERR Initiated	Link Failures	RERR Received	Packet Delivery Ratio	Max MOS	Min MOS	RERR Initiated	Link Failures	RERR Received
30	0.89	3.297	2.37	11	18	17	0.83	3.299	2.03	29	24	41
60	0.87	3.295	1.51	57	67	118	0.97	3.295	2.08	19	29	38
90	0.84	3.295	1.53	111	71	156	0.91	3.295	0.99	51	37	153



(a)



(b)

Fig. 4: (a) Comparison of AODV and R-AODV for Packet delivery Ratio for VOIP traffic type (b) Comparison of AODV and R-AODV for link failures for VOIP traffic type

Table 7: Comparison of VOIP traffic for LAR and R-AODV

Nodes	LAR						R-AODV					
	Packet Delivery Ratio	Max MOS	Min MOS	RERR Initiated	Link Failures	RERR Received	Packet Delivery Ratio	Max MOS	Min MOS	RERR Initiated	Link Failures	RERR Received
30	0.83	3.23	2.37	63	39	17	0.87	3.5	2.1	46	37	41
60	0.87	3.25	1.45	57	31	118	0.9	3.53	2.0	19	29	38
90	0.89	3.3	1.23	45	29	156	0.92	3.6	1.99	51	24	32

In Table (7), a comparison has been made in Location Aided Routing (LAR) protocol (Sharma *et al.*, 2014) and Routing based AODV (R-AODV) as location of nodes are playing very important role in calculating predicting lifetime in R-AODV. Definitely, LAR also has a good account of location based values to carry out the processes or any type of application be it video streaming, audio streaming or video chat. LAR uses location information using global positioning system to improve the routing mechanism in order to improve packet delivery ratio.

In VOIP traffic, network layer metrics like Minimum Mean opinion score and maximum mean opinion score are also taken into consideration as these metrics are clearly quality metrics which will help us to measure the quality of video and audio applications. Here, maximum mean opinion score has really improved with R-AODV. In this particular scenario Graphs 5(a-b) depicts that link failures are more in lesser number of nodes with R-AODV when compared with AODV. But when nodes are increased, link failures and RERR messages generated have decreased a lot with new proposed R-AODV routing protocol as compared to AODV. Further it can be deduced that, in urban scenarios , this protocol works better as node congestion increases, but when nodes are sparsely located like highway scenarios, standard AODV is performing better.

To summarize, our proposed protocol R-AODV has shown better performance than standard AODV routing protocol for constant bit rate, variable bit rate and voice over internet protocol traffic. It has shown clear increase in packet delivery ratio and decrease in number of route error RERR messages generated. Video streaming has been evaluated and results have been tabulated here in Table (6).

Table (8) clearly indicates that PSNR gains have been achieved indicating that performance has been improved for video streaming applications. Although we have the measure for Mean Opinion Score (MOS) but PSNR gives us more objective value. But PSNR value is a clear measure of the quality of service of a video.

Table 8: PSNR gains with R-AODV

Video sequence	PSNR gains with AODV	PSNR gains with R-AODV
Foreman	28.33	29.67
Coastguard	32.56	34.88
Mother daughter	31.89	33.56

Conclusion

To discuss the above results and analyzing them meticulously, there are various observations to put forth with AODV and R-AODV and it has been observed that our new protocol R-AODV has really enhanced the performance of the video streaming applications when seen at both application layer level and network layer level. It has guaranteed PSNR gains for different video sequences which gives us a metric help for enhancing video streaming applications over VANETs. As this new proposed protocol works on the basis of position and velocity of nodes, it can be further compared with the position based routing protocols like Greedy perimeter stateless routing protocol GPSR (Karp & Kung, 2000), Vehicle assisted data delivery VADD (Zhao & Cao, 2006) and A-star (Vaishali *et al.*, 2013) routing technique. The metrics of both layers have been taken into consideration. R-AODV has shown better results as compared to standard AODV when implemented on different scenarios as different traffic types like Constant Bit Rate (CBR), Variable Bit Rate (VBR) and Voice over Internet Protocol (VOIP) applications. Various metrics like increased packet delivery ratio , average Mean Opinion Score (MOS) (Seet *et al.*, 2004), decreased packet loss ratio , decreased link failures and less RERR messages generated is a clear way to authenticate that proposed routing protocol R-AODV has improved the performance of applications and shown equally well with CBR, VBR and VOIP applications at the same time. The advantage of this study is that it has got no extra overhead as the analysis is done on RERR messages itself. This approach is purely based on standard routing messages. A statistical model can be followed for determining the packet losses. As packet losses are not completely accurate, there may be unnoticed packet losses sometimes. In future, this new hybrid protocol can be implemented on FTP, TELNET traffic types for seeing the variations and also by varying velocities of nodes, pause times of nodes and distance between the nodes. This R-AODV can also be compared with more routing protocols available for VANETs.

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Author's Contribution

Both the authors have equally contributed to this manuscript.

Ethics

The author affirms that there is no conflict of interest among the authors and the work complies with the ethical policies of journal of computer science have been followed.

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