Routing Stability Important Factor in Streaming in VANETS

Pooja Sharma, Ajay Kaul, and M. L. Garg

Abstract VANETs are a subset of MANETs that are essentially vehicular ad hoc networks, a type of Ad hoc Network. By considering the resource requirements of various applications, networks make resources accessible to these applications in order to maximize the network usage. However, when Ad hoc networks are considered, it is highly difficult to offer these resources to applications when there are variable resources, such as bandwidth, which changes every time when Ad hoc networks are considered.

Keywords MANETs · VANETs · QoS · Routing protocols

1 Introduction

Vehicular Ad hoc networks (VANETs) are Ad hoc networks in which nodes move at high speeds in a predetermined pattern, as opposed to MANETs in which nodes move randomly [1]. However, MANET nodes move at random and clearly not as quickly as VANETs. Bandwidth, energy, latency, jitter, and channel capacity are all required for various applications. By considering the resource requirements of various applications, networks make resources accessible to these applications in order to maximize the network usage. However, when Ad hoc networks are taken in consideration, it is extremely challenging to provide these resources to applications, when it has dynamic resources such as bandwidth that changes every time when Ad hoc networks are discussed. Many external factors influence the performance of applications using ad hoc networks.

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1.1 VANET Characteristics

Ad hoc networks first appeared in the 1970s, when networks were known as packet radio networks. VANETs must prioritize safety and traffic management [2]. Vehicles or nodes can alert other vehicles of impending difficulties such as road conditions, traffic congestion, or sudden halt. IEEE 802.11p mentions a new physical layer as well as a Medium access control (MAC) layer for vehicle communication [3, 4]. Maintaining the quality of service parameters is one of the most difficult tasks in VANETs. Due to the great mobility and complexity of vehicle flow, trustworthy data streaming via vehicular Ad hoc networks is a challenging task when compared to mobile Ad hoc networks. Vehicular Ad hoc networks are always important in smart cities, especially for safety applications and video monitoring services. Vehicles assist cooperative drivers and first aid personnel in sharing real-time information about accidents in a certain region. As a result, we require a robust way to sharing such critical information through the use of resilient routes even in multi hop, multi path, and dynamic environments [5]. Human-shared and viewed videos are described in terms of quality of service (QoS) and quality of experience (QoE), which is entirely based on user acceptance. Connectivity is a measure of the network's reachability, and it is critical to the QoS performance of vehicular Ad hoc networks. When they are in each other's transmission range, they are said to be connected.

There are various approaches, which work on improving the quality of service (QoS) of video streaming applications like clustering, cross layer design, data dissemination, opportunistic forwarding and many more [5, 6]. All these techniques help in improving the performance of VANET applications.

Video streaming is one of most critical and delay sensitive applications, which is highly sensitive to delay, jitter, data rate, loss rate and error rate. Route stability is one of the big factors employed in evaluating the quality of service of streaming applications as the more the routes are stable, where the more packets are transferred per unit time, thus increasing packet delivery ratio. If the packet delivery ratio is increased, quality of service of video streaming applications is increased. Therefore, in this thesis, to address the problem of video streaming applications over VANETs because of unstable routes as route are broken frequently in vehicular networks, the standard protocol Ad hoc On Demand routing Vector (AODV) [7] is modified by incorporating route stability. To make routes more stable, one new metric called minimum lifetime is added to the links by which we can predict and chose a path which has maximum minimum lifetime. Hence, problem is to maximize the minimum lifetimes of each of the link which in turn makes a path. This metric minimum lifetime has been given by Vinod Namboodri et al. it is based on various parameters like range of wireless networks, distance between two nodes and velocities of two nodes. In [8, 9] various routing strategies attempt to provide a stable route among nodes and ensure quality of service. Reliability of links are very important for the stability of a particular route [10]. By incorporating this route stability factor, there is an improvement seen in the throughput of video applications when they are transmitted as CBR and VBR traffic (Fig. 1).

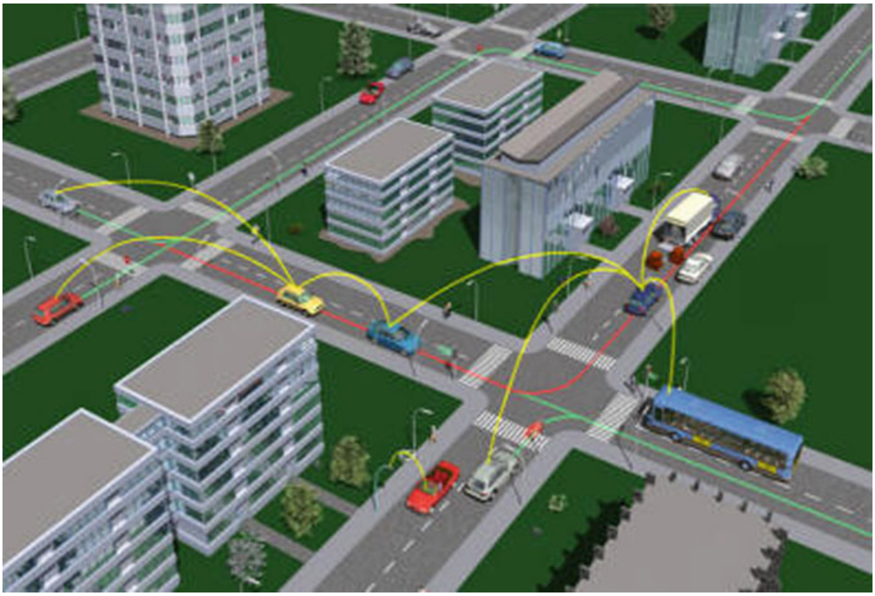

Fig. 1 VANET scenarios

At the same time, when video is transmitted as Voice over Internet Protocol (VOIP) traffic [11], there is a clear increase shown in mean opinion score (MOS) [12] is defined as a subjective metric to compute the quality of video at the application level. PSNR is one of the subjective parameter used to evaluate video quality. PSNR is computed with respect to the input video and received video in order to evaluate quality of video. There is a reduced delay and jitter which in turn improves the performance of an application. Our motive is to optimize the performance of applications over VANETs. Another important contribution of this thesis is that route error messages also decrease due to less route failures which in a way reduces packet losses.

Mean opinion score is a commonly used measure for video, audio and audio video quality evaluation. The MOS is expressed as a single rational number, typically in the range of 1–5. 1 is the lowest perceived quality, whereas 5 is the highest perceived quality. With reference to the multimedia, quality of service-based approaches assess the quality of streaming services through network oriented metrics. By taking the mean opinion score into consideration in simulation, performance of video streaming applications can be evaluated in a better way. Some of the ways for measuring video quality has been considered like packet loss ratio, mean opinion score, link failures and they are compared with its counterpart modified AODV where predicted lifetime has been taken into consideration. We can definitely include other video quality measures like PSNR. Algorithm has been modified with additional parameters like distance and speed of nodes. Comparison with other routing algorithms has been mentioned in future work. We have compared R-AODV with one routing protocol

Location aided routing as it is also location-based protocol. R-AODV has shown better performance than LAR [13].

2 Resource Provisioning for Video Streaming in VANET

The advantage of bit stream is that it allows to conduct simulations, where the quality of video after suffering losses in the network is evaluated [14]. One limitation of bit stream per second that bit stream is large in size [15, 16]. Another limitation is that they are usually proprietary protected by copyright. Therefore, network researchers are limited to bit streams and also limit the exchange of bit streams across the research groups. Generally, it is advised to cover more and more videos in order to cover maximum features in different scenarios. In a study, [17] has discussed many examples for scalable and non-scalable encoders. The video traffic trace is an abstraction of real video stream. It typically gives the frame, frame type (P, B, I) and frame size in a text file to characterize the real video traffic [18]. After decoding the video, performance can be evaluated by metric such as peak signal to noise ratio (PSNR). Video stream can be seen as a constant bit rate traffic (CBR) and variable bit rate (VBR) traffic. CBR traffic is mainly for real-time data dissemination and would be appropriate for voice and video application. CBR carries traffic at constant bit rate. Real-time variable bit rate is used for traffic which carries data at variable bit rate. Example is compressed video. Non-real-time variable bit rate is for VBR traffic where there is no reliance on time synchronization in traffic source and traffic destination. Constant bandwidth has to be guaranteed for CBR type of traffic. VBR traffic is meant for real-time and non-real-time data, i.e., which has changing traffic characteristics. This helps us to compare certain new hybrid protocols with the standard protocols on different parameters such as packet delivery ratio, packet loss, delay and jitter.

We need to provide resources in vehicular Ad hoc networks so as to have smooth execution of network applications, especially video streaming applications. Video streaming applications requirements are studied with an insight to delay, jitter, bandwidth requirements, throughput, etc., these metrics help us in assessing the quality of service for video streaming applications. Other network applications are also to be studied in order to study the effect of routing protocols in VANETs, especially with their characteristics like frequent disconnections because of high mobility of VANET nodes. When we need to provide better resources, we have to find stable routes, increase throughput, decrease delay and jitter so that quality of service of network application is maintained [19]. V2V communication is very important for ensuring safety and reliability of passengers in vehicles. Delay time is decreased by reducing route failures since it is proportional to the time it takes to send route error messages and time for retransmission. However, when a route is already chosen by considering its stability, route error messages and latency will also reduce, resulting in improved application performance. Also, a higher throughput and reduced latency and jitter has been observed. Henceforth, this research work is very much in compliance to optimize and improve the performance of applications over VANETs.

3 Motivation

When it comes to intelligent transportation systems, VANET is considered as an emerging research area. It also possesses the requirement to have vehicle-to-vehicle communication, vehicle-to-infrastructure communication, and infrastructure-to-vehicle communication. These VANET connections significantly contribute to the safety of drivers and passengers. Traffic congestions and accidents ahead will be known earlier and appropriate action can be taken by driver and passenger. More live updates can also be availed by drivers [20, 21]. Vehicular Ad hoc communications are as critical as the speed of nodes, which is more comparable to vehicle nodes that lead to frequent disconnections of vehicles since the vehicles join the Ad hoc network and leave the network in less time [22]. This comes up with the need to look stable path, i.e., where nodes shall remain connected for more time. When nodes are connected, they form a stable path and lead to better throughput and packet delivery ratio for all kinds of network applications, especially time constrained applications like video streaming applications.

There are various metrics that can be considered for evaluating and assessing the quality of service of video applications like throughput, delay, jitter, bandwidth, response time, packet loss rate, error rate. Various link stability factors have been studied in literature, they are frequency and bandwidth. Various challenges of VANET communications should be considered, they are security, authentication, integrity, confidentiality, accessibility, scalability, reliability, and media access control. The security of message content has been an issue for communication. The message received needs to be verified in a short period of time so as to use the information at the earliest [23, 24].

Considering the link stability, the distance between two nodes play a very important role in connectivity, the lesser the distance between two nodes, the more they are connected. When they are approaching each other, they are connected and when they go away from each other, slowing going out of range and get disconnected.

Route stability is incorporated in standard AODV which is very helpful in making robust video transmission in VANET nodes as route stability is one of the key factors in Ad hoc networks as there is no predefined infrastructure. Route stability is used to determine the time for which route will be stable or the link between two nodes is alive or connected. In VANETs, where nodes are moving with high speed leading to more route breaks and in turn increasing RERR messages.

There has always been a focus on the beginning of VANET research present time. Early work focused on finding feasible routes without considering predicted lifetimes of links or QoS. A preemptive routing has been used in the general context of mobile Ad hoc networks, but never for vehicular Ad hoc networks [14 , 25, 26] PBR.

AODV protocol is widely used reactive routing protocols. In AODV, node broadcasts a RREQ packet, when it wants a route to specific host. Each node that receives route request (RREQ) packet checks whether it is the destination node, if it is, it sends a route reply (RREP) packet, otherwise it rebroadcasts a route request packet. The intermediate node forwards the RREP packet to the source according to their routing tables. One unique point in AODV is that nodes use “Hello” messages to probe their neighbors in order to validate routes Problem to address here is to optimize the performance of video streaming applications in vehicular Ad hoc network by using hybrid routing protocol in turn improving mean opinion score (MOS), packet delivery ratio, thereby reducing delay, jitter and packet loss ratio by reducing route error (RERR) messages, while disseminating video over Ad hoc networks.

4 System and Proposed R-AODV Routing Protocol Model

In the proposed routing protocol, standard AODV protocol is modified with one additional metric which is predicted lifetime of a link. Predicted lifetime is the lifetime for which nodes will remain connected. This lifetime has been calculated on the basis of distance between nodes and speed of the nodes or vehicles. This prediction will help us to predict the time for which nodes are going to be connected before selecting a route, a path is chosen on the basis of minimum predicted lifetime of a link which will form the part of route. Every route is made of certain links from source to destination and each link having predicted lifetime.

Our proposed protocol works for changing coordinates as they are changing frequently in VANETs. These estimates will not be stale as this will take very less time and would not take so long. Moreover, the calculation is updated according to the distance between nodes. Distance will keep changing according to the position of nodes. As long as distance is within the transmission range, nodes will remain connected. Every node’s position and speed will be updated in RREQ packet by functions myposition(), myspeed().This info is used. Distance will be calculated for that time period only when two nodes will be connected. Coordinates of both nodes have been taken into account to calculate the distance. Actually both nodes are moving, it is for that particular time period. In real life, it can be deduced when distance is increasing between nodes/ vehicles, they are going away and will lose connection after a particular range. Moving nodes are taken into consideration by their direction and speed.

The route from source to destination is selected where we have maximum value for minimum predicted lifetime. It is a way to obtain the maximum of minimum predicted lifetimes. We are going to maximize the minimum predicted lifetime of various links forming the route. It will predict the stability of route formed from source to destination. In standard routing protocol AODV, RREQ and RREP messages can be seen in figure given below in Fig. 2.

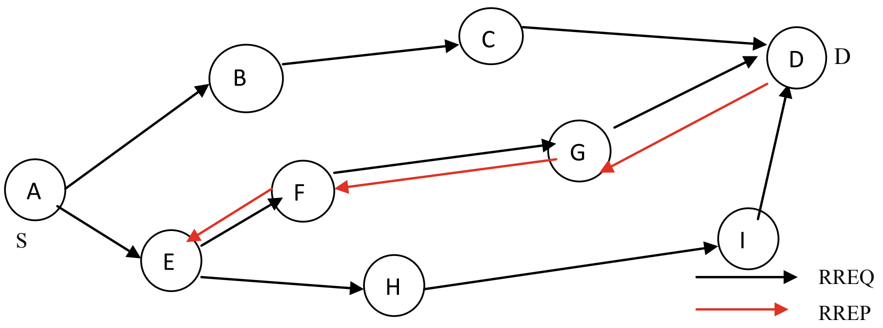

Fig. 2 RREQ and RREP messages in AODV

RERR messages can be seen in figure mentioned below. RERR messages are generated when link breaks. Every time a link is broken, RERR message is generated as shown in Fig. 3.

Now, modified figure for R-AODV is seen here with predicted link lifetimes given and deciding\on the basis of maximizing the minimum lifetime for which route will remain stable. The predicted lifetime is used to give the source a predicted lifetime for the route. This metric will help in forming better and stable routes. The route chosen will be on the basis of predicted lifetime of each link and in turn route lifetime is minimum of all the value of lifetimes of links. Initially, a node puts its location and velocity information and sets a lifetime field in the RREQ packet header equal to some value that is expected to be greater than the minimum of all link lifetimes along the route. The lifetimes of links are represented here as LLT1, LLT2 as shown in Fig. 4.

We can observe changes in routing in these transmissions.

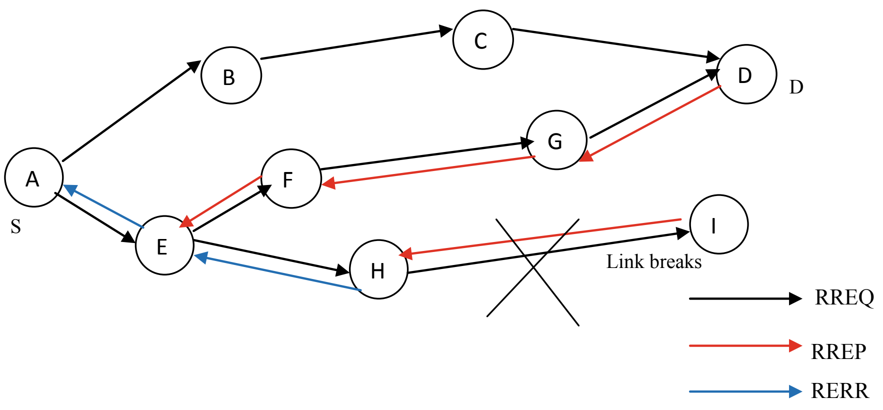

Fig. 3 RERR messages in AODV

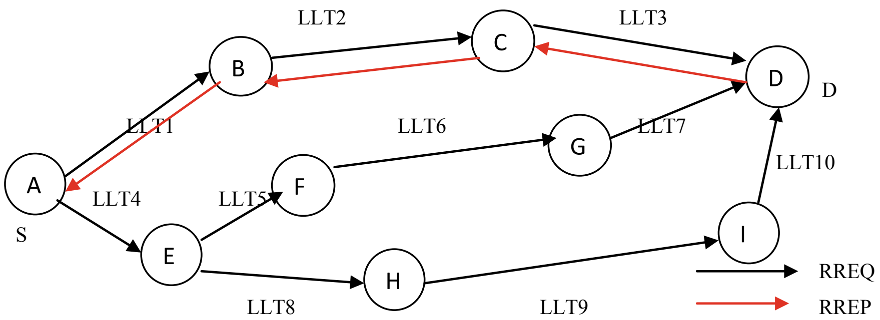

Fig. 4 RREQ messages along with link lifetimes

5 Conclusion

Different network applications have varying resource requirements, which have been carefully examined in this research article. The goal of investigating and evaluating various resource needs in terms of quality of service characteristics is to aid in the intelligent use of resources in networks, particularly in Ad hoc networks such as vehicular Ad hoc networks. Furthermore, a few quality of service (QoS) factors such as constant bit rate (CBR), variable bit rate (VBR), and video traffic have been considered to assess the performance of video streaming applications.

The proposed routing protocols would also reduce the number of route error (RERR) signals issued and link failures, resulting in more resilient routes. As route stability is very much related to number of route error (RERR) messages, a decrease in number of RERR messages for different scenarios of vehicular Ad hoc networks will routinely improve the route stability.

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