A Comprehensive Study of Requirements for Network Applications and Routing Protocols Providing Resources in Vehicular Adhoc Networks

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Abstract— Vehicular adhoc networks are special form of Mobile adhoc networks which have more dynamic topology than MANETs but the nodes move in a preordered fashion. Due to the high mobility and complex dynamics in real vehicular traffic flow, reliable streaming of data over Vehicular adhoc networks is a challenging task as compared to the other general mobile adhoc networks. This paper gives an overview of traffic classification system, resource requirements of applications and efficacy of the routing protocols viz a viz the protocols which help in improving Quality of Service (QoS) of those applications when running on vehicular adhoc networks. This paper throws light on various requirements of applications in terms of QoS metrics and meeting them in an infrastructureless scenario i.e adhoc networks with the help of various routing protocols. VANETs are going to be an important communication infrastructure in our life. Because of high mobility and frequent link disconnections, it becomes quite challenging to establish a robust multi path that helps packet delivery from the source to the destination.

Index Terms— VANETs, MANETs, Routing Protocols, QoS, QoS metrics

I. INTRODUCTION

Internet traffic is broadly classified into two categories i.e real time applications or time critical traffic and the non real time applications or elastic applications. Real time traffic is further divided into two forms viz a viz real time streaming applications and real time control applications eg machine control, games. Examples of non real time applications are web browsing, email, FTP and telnet. Few of the real time and asymmetric applications are audio broadcasting, video broadcasting, interactive audio on demand, interactive video demand. Real time and symmetric applications are those which are conversant in nature such as teleconferencing (video and audio conferencing) and Voice over Internet protocol (VOIP).

Real time streaming is further of two types, one is rigid and intolerant applications and the other tolerant and adaptive applications. Real time applications have very strict (Quality of Service) QoS constraints such as real time audio/video streaming applications due to the strong sensitivity of the human sound perceptions and can become tolerant to QoS interruptions by means of adaptation whereas adaptive applications are capable of adjusting their playback point according to the observed network QoS.

The network links have specific QoS characteristics with respect to delay, jitter, bandwidth and reliability. The QoS properties of network links depend entirely on the link layer characteristics and physical
transmission medium. The effectiveness of different protocols according to the requirements of the applications has to be studied so that resources can be provided in best possible manner in vehicular adhoc networks. Different protocols work on different QoS metrics. Different needs of the applications can be catered by combination of one or more protocols. The requirements for various network applications have been surveyed on the basis of QoS metrics. There are some protocols which work better under one scenario than the other scenario. Some protocols have already been implemented for some specific application in vehicular environment in a particular scenario, but are yet to be implemented on other applications and in different scenarios. This study makes a comprehensive review of provisioning of resources in adhoc networks for various network applications in best possible manner according to their requirements.

II. LITERATURE REVIEW

The existing literature has been reviewed considering different requirements of applications and providing them with resources with the help of various routing protocols. Y Chen [1] 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 T.K Wok [2]. Some of the data has been taken from [3] regarding bandwidth, delay and jitter requirements for video streaming, VOIP, Interactive video etc. In continuous media, especially audio and video data has spatial relationships that must be taken care of. The requirements of time critical applications are commonly expressed as a set of values representing bandwidth, delay, jitter and loss rate. Continuous streaming applications can cope with QoS which is significantly lower than real time streaming applications. Various voice encoding techniques such as G.711, G.726, G.727, G.728 are there, similarly several encoding or compression technique for CD quality sound have been developed such as MPEG Layer-1, MPEG Layer-2, MPEG Layer-3.

A set of QoS parameters suitable for characterizing the quality of service of individual connections or data flows is as follows

Delay: End to end delay is the elapsed time for a packet to be passed from the sender through the network to the receiver. For interactive or real-time applications the introduction of delay causes the system to appear unresponsive and as a result in many cases unusable.

Jitter: The variation in end to end delay is called jitter often referred as delay variation. High levels of jitter are unacceptable in situations like real-time applications.

Bandwidth: The maximal data transfer that can be there between two end points of a network is defined as the bandwidth of the network link. Network applications have a certain bandwidth disposable between two nodes but the amount of data they really transmit is computed by their throughput which is governed by the relation

0<Throughput<Bandwidth

Reliability: This property determines the average error rate of the network. The error rate can be subdivided into bit error rate and packet or cell error rate.

There are various routing protocols available which improve QoS. They are also called as QoS aware protocols. The Existing routing protocols are classified and characterized for vehicular adhoc networks. VANETs applications such as audio/video conferencing, web casting requires very stringent and inflexible Quality of service. The provision of QoS guarantees is much more challenging in VANETs than wired networks. QoS is the performance level of a service offered by network to the user. Most of the multimedia applications have stringent QoS requirements that must be satisfied.

From the studies conducted by Jerome Hearri et al in [4], it has been deduced that clustering effects created by cars aggregating at the intersections have remarkable impacts on evaluation and performance metrics. AODV and OLSR have been studied in urban environments under varying metrics such as node mobility and vehicle density and with varying traffic rates. AODV outperforms OLSR in terms of Packet delivery ratio. Indeed OLSR has small routing overhead, end to end delay and route lengths. This had a limitation that the network is parameterized to be fully connected so as to avoid biased results from disconnected graphs.

Liu Jincui et al in [5] have compared Adhoc On demand Distance vector (AODV) and Dynamic Source Routing (DSR) and inferred DSR is better than AODV under relative loose condition i.e less nodes and less mobility and the AODV is better than DSR under relative rigorous condition. AODV delivers successfully a slightly greater fraction of packets than the DSR. It is found that DSR has overhead and is suitable to networks in which not all nodes need a route to every other node in the network and the user traffic is low. DSR works well for lesser nodes hence scalability issue is there. DSR uses the route storage continuously and
its Packet Delivery Ratio (PDR) of it is greatly influenced by the big area when large amount of target nodes and source nodes exist in network and mobility of the nodes is quite high.

Transmission Delay of AODV is less than DSR when there is short pause time i.e relative high speed is there but delay in DSR is more than AODV in the scenario when pause time becomes longer. The route overhead of DSR is lower than that of AODV and the DSR is more stable than AODV. This is because the route overhead of AODV is determined by the RREQ packets and route overhead of DSR is determined by the RREP packets. Hence AODV is better in urban scenarios and delivers successfully greater fraction of packets. However, work done by Xiong Wei and Li Qing Quan in [6] reflects a comparative study of AODV, DSR and DSDV routing protocols in variety of highway scenarios characterized by the mobility, load and size of the network. Their results show that AODV and DSR have similar performance; the AODV shows better performance for large network size measured in number of nodes whereas DSR shows good results for smaller network size. DSDV is considered totally unsuitable for the scenarios considered. It is also shown here that those routing protocols dedicated for MANET is totally unsuitable for VANET scenarios in terms of PDR, routing load and end to end delay.

Fei Xie, A Hua, Wenjing Wang and Yao H Ho[7] have described study of live video streaming over highway vehicular adhoc networks. Two network metrics, packet delay and packet loss greatly affect the quality of the video at the receiver end. In video streaming, a single video frame is decomposed into many smaller packets and sent into the network. Authors in [8] of live video streaming have proposed fast triggers which use a distributed method to estimate the backward and frontward transmission ranges of vehicles. Although, video streaming requires a buffer , yet by increasing buffer size may not always improve the quality of service of transmitted video. In real sense buffer overflow is unavoidable. Dense networks are more connected networks. Highways are one dimensional, so there is no path diversity which can be explored on the highway. If a network is connected different data forwarding schemes should have similar performances. The proposed SBF-H (Sender based forwarding) and RBF-H (Receiver Based Forwarding) have been compared and analyzed proving that RBF-H can achieve the best video quality under all traffic conditions.

Mahdi Asefi in [9] propose an application centric routing framework for real time video transmission over urban multi hop vehicular networks. In this study, author has translated the design of routing protocol into an optimization problem using a probabilistic model to formulate average end to end distortion of the delivered video frames over the entire video session. Performance of the protocol in different vehicular scenarios versus increment in coverage area through more communication hops has been evaluated.

Abdullah Jamali and Naja N have discussed the study of QoS issues for multimedia and real time applications[10]. Conclusions have been drawn on the basis of simulations for adhoc network routing protocols such as AODV, DSR, optimized Link state routing(OLSR), Temporally ordered routing Algorithm (TORA) and Geographic Routing Protocol (GRP) for multimedia streaming. It has been observed that choice of routing protocols depends on the network size. OLSR and GRP have a good adaptability with the great network size.

In [11] many QoS routing strategies attempt to provide a robust route among nodes and ensure quality of service. Various factors like link delay, node velocity and trajectory, node position , distance between nodes and reliability of links all contribute to the stability of a particular route. This paper discusses MURU (Multi Hop Routing Protocol for urban), GvGrid uses divide and conquer strategy, PBR (prediction Based Routing) and DeReQ (Delay and reliability constrained QoS routing algorithm).

The important building blocks of PBR protocol are obtaining location and velocity information of vehicles on the route to the gateway. Its basic operation is to create routes in the same way as reactive protocols. When a node wants to communicate, it sends route request (RREQ) packet with a TTL (time to live) value that specifies the number of hops to search for a gateway. In PBR , the lifetime of link between i and j is predicted as

$$\text{Life time}_{ij} = (R - |d_{ij}|) / \left| v_i - v_j \right|$$

Where R is communication range of WLAN technology, \(|d_{ij}|\) absolute distance between nodes i and j, \(v_i\) and \(v_j\) are velocities.

since a route comprises of one or more links, the route lifetime is the minimum of all its link lifetimes as done by Vinod Nambudiri in [12]. With low vehicle density in the forward direction using routes through oncoming vehicles has an effect similar to doubling the vehicle density in the forward direction in terms of connectivity. Vehicle and gateway density is studied for the scenario where there is adequate connectivity. It is seen that node density does not have any effect on route lengths at all and also on route failures. As gateway density increases, the route length and number of route failures rise. Since smaller route lengths
minimize the frequency of route failures. Large node density helps in improving connectivity. PBR has been compared to reactive and proactive routing protocols. The dropped packets ratio of PBR is much smaller than that of the reactive protocol which is to be expected. PBR decreases route failures and also reduces the number of routes created because if routes are more stable, preemptive route creation intervals will be larger. The overhead of PBR is not a big issue for mobile scenario, as it can lead to smaller throughput and higher energy consumption. Energy supply here is relatively abundant. Regarding throughput, when nodes connect to internet, the bottleneck link in terms of bandwidth is the WAN link from gateways to the base station. Factor of randomness is also added to PBR and observed that the effect of randomness is the smallest when the gateway density is very high, the higher density of gateways on the road the smaller the ill effects of randomness and better the performance of PBR. PDR is very high for all possible values of p (varying randomness) to the maximum possible 0.5. GvGrid protocol [13] is also very suitable for urban scenarios where vehicles move at slower speeds in dense traffic. It is not clear that whether GvGrid guarantees any particular QoS level in terms of bandwidth or link delay. This can be further entailed for discussion. In [14] authors present a multi hop routing protocol called MURU which is able to find robust paths in urban VANETs to achieve high end to end PDR with low overhead. A metric known as EDD(Expected disconnection Degree) is used to select the path from source to destination. In this study, simulation results show that MURU outperforms existing routing protocols for adhoc networks. A route request packet header also carries the value of EDD path. This study compares AODV, DSR, GPSR and MURU. It has been seen that data delivery ratio of AODV, DSR and GPSR keep same or slightly increase as the network density increases, however data delivery ratio of MURU is much higher than 50% as the number of mobile nodes is 80 and ratio significantly increases as density increases. The limitation with GPSR is that it periodically sends beacons by which its overhead is proportional to the number of nodes. This is not the case in AODV, DSR and MURU, so overhead here is very less as compared to GPSR. It is also found that MURU has lower average delay than that of AODV and GPSR. The delay of MURU decreases as network density increases. In [15], author presents an intersection based geographical routing protocol (IGRP) which outperforms existing protocols for city environment. It is based on the selection of road intersections through which a packet must pass to reach the gateway to the internet. Author has tried to improve the transmission range Tr. When road density increases, Tr should be reduced to avoid interference and then reduce the error rate without deteriorating the network connectivity. It is noticed that connectivity probability increases with the increase in transmission range. Likewise BER increases when increasing the transmission range. To achieve a low BER, the transmission range should then be decreased. In simulations, Tr is selected to be the value that results in connectivity 1 and at the same time results in low BER. Comparison of IGRP is done with the performance of GPCR, GPSR and OLSR. In simulation scenario, end to end delay, hop count and BER for all protocols as a function of the number of nodes in the network respectively. Delay increases with the increase in network density. IGRP selects routes with higher number of nodes to achieve higher connectivity probability and meet the delay, hop count and BER constraints however in GPSR and GPCR, more nodes are allowed to store and forward mechanism, which decreases the probability of connectivity and increases delay. Overhead of IGRP is that it does not choose routes that have a very high number of nodes(high density), which results in less network contention and then lower BER. In [16] author has discussed multiplayer online games which should have minimum delay and jitter. Recognizing the challenges and opportunities in the VANET environment implies for games, author has proposed a new paradigm for games in VANETS, one that adapts to the specific environment constraints and makes use of its inherent dynamic characteristics. With the help of [17] author determine the upper performance bound for connection duration, PDR, end to end delay and jitter for unicast based typical highway and urban VANET environments. This area needs to have more research. Definitely, Games would have to have hard QoS constraints. In another study by Akhtar Husain et al in [18] conclusion is drawn that position based routing protocols gives better performance than topology based protocols in terms of PDR, throughput and end to end delay for both vehicular traffic scenarios. Author has not included transmission range in his study. G Lorkmaz et al in [19] discussed urban multi hop broadcast in VANET. Urban Multihop broadcasting (UMB) has improved upon reliability of broadcast by alleviating a hidden terminal problem through an RTS/CTS style handshake and broadcast storms through black burst signals to select a forwarding node that is farthest from the sender using location information. Gounjun Yan et al [20] proposed routing protocol which improves QoS of VANET in terms of delay, response time and throughput. Considering the DSR and AODV, improvements are done and a protocol
named as VOA (VANETs quality Of service by Adaptive protocol). In this scheme, wireless links are based on the expiration time of the link which is calculated on the base of vehicular relative velocity vectors. One backup route in this approach is always there which can be switched as the primary route when the current route is about to break. When both current and backup route are broken, local or global path repair will be activated. Simulation results prove that the proposed protocol improve bandwidth, routing duration and response time. QoS is improved as retransmission delay caused by route breakage is reduced. Further, this protocol can be applied to city environment and simulating on real traffic scenario. Das et al in [21] compared a large number of protocols. However, link level details and MAC interference are not modeled. Another study [22] compared the same protocol as the work done by Broch et al [23] yet for specific scenarios as the authors understood that random mobility would not correctly model realistic network behaviors. Globally it is concluded that reactive protocols perform better than proactive routing protocols.

Pradeep Macharala in [24] proposed an on demand QoS routing protocol (AODV-D) for delay sensitive applications in mobile adhoc networks in order to overcome shortcomings of existing QS-AODV and AODV protocols. It estimates node delay dynamically instead of taking a constant value as in the existing QS-AODV[25]. This provides more accuracy in estimating end to end delay.

One of the studies done by Anil K Bisht et al in [26] evaluate the performance of the position based routing protocols in vehicular network environment. The metrics such as packet delivery ratio, throughput, end to end delay and routing overhead are evaluated using ns2. The protocols were tested by differing transmission range and node density. It is found that LAR (location aided routing) [27][28] outperform DREAM (Distance routing effect algorithm for mobility )[29]. DREAM is a directional, restricted flooding position based routing protocol. [30]. LAR is on demand routing protocol like AODV and DSR with an additional use of positional information to improve the route discovery phase of reactive adhoc routing approaches.

Lei Chen et al in [31] proposes incorporating QoS into routing and introduces bandwidth estimation through “Hello”messages. Two different techniques for bandwidth estimation is done using “Hello” and “Listen”. In mobile topology “Hello” performs better in terms of end to end delay and “Listen” performs better in terms of packet delivery ratio. Listen does not have any overhead but “Hello” has overhead by attaching neighbours bandwidth consumption information in the hello messages.

Bijan Paul et al [32] discussed merits and demerits of various routing protocols. FSR (Fisher eye State Routing) [33] reduces significantly the consumed bandwidth as it exchanges partial routing update information with neighbors only. Disadvantages are very poor performance in small adhoc networks, there is less knowledge about distant nodes.

GPCR (Greedy perimeter Coordinate routing) [34] is a position based routing protocol uses greedy greedy algorithms to forward packet based on a preselected path which has been designed to deal with the challenges of city environment. It has a problem in junction detection approach in which first approach fails on curve road and second approach fails on a sparse road.

Connectivity Aware Routing (CAR) [35] is designed which uses AODV for path discovery. Its benefit is that it has no local maximum problem. CAR ensures to find the shortest connected path because CAR has higher packet delivery ratio than GPSR. Limitation of CAR is that unnecessary nodes can be selected as an anchor and it cannot adjust with different sub path when traffic environment changes.

VADD (Vehicle assisted Data Delivery) [36] is based on the idea of carry and forward approach by using predictable vehicle mobility. VADD performs high packet delivery ratio and suitable for multi hop data delivery but due to change of topology and traffic density it causes larger delay which makes it unsuitable for application which are tightly constrained by delay requirements.

Fleetnet [37] provides internet access as well as communication between passengers in cars in the same vicinity allowing them to play games. A pure V2V cannot address these applications domains and there is a definite need for V2I infrastructure.

The extant literature suggests certain findings which will be discussed in next section. Various solutions have been discussed to improve QoS by different authors. However, few works related to online games, 2D videos, effects of traffic lights on various routing protocols have not been discussed.

III. ANALYSIS

The above mentioned literature review leads to certain findings. Video streaming applications can deploy routing protocol viz a viz Multi hop urban Routing Protocol (MURU), Prediction based routing protocol (PBR). Some Protocols like Application aware Quality of service (AAQR), Delay sensitive adaptive routing
protocol (DSARP) have already been implemented on MANETs and can further be implemented on VANETs. It is being observed that GvGrid routing protocol does not guarantee any particular QoS metric in terms of bandwidth or link delay. AODV shows better performance for most of the applications in highway scenarios in vehicular environment, however DSDV is considered unsuitable for VANETs. There is no comparative study done on MURU and (Delay and reliability constrained QoS algorithm ) DeReq as both are more concerned about reliability and stability of path selected for data transfer.

Some of the solutions have been selected to discuss their suitability for video transmission and compare their performance. Few of the techniques like WAVE (Wireless access in vehicular environment), NCDD (network coding based data dissemination) described in detail in [38] and REACT-DIS (Reactive, Density Aware and Timely Dissemination) Protocol to form a reliable cross layer technique as they handle video streaming challenges in different protocol layers, which can offer high delivery ratio, low end to end delay while keeping transmission costs limited. None of the proposed solutions yet discuss solutions which has optimum performance in both urban and highway scenario. Definitely, online games and 2D videos transmission need certain attention. There is less study of impact of traffic signs, traffic lights on the performance of routing protocols.

Some of the findings have been tabulated in Table 1 as mentioned below and which can help us to focus on certain thrust areas.

### Table 1 - Requirements of Applications in Terms of QoS Metrics

<table>
<thead>
<tr>
<th>Application</th>
<th>QoS Metrics</th>
<th>Response Time</th>
<th>Delay</th>
<th>Jitter</th>
<th>Data Rate</th>
<th>Required BW</th>
<th>Loss Rate</th>
<th>Error Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email</td>
<td></td>
<td>2-5 s</td>
<td>Low</td>
<td>N/A</td>
<td>&lt;10K</td>
<td>&lt;10K</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Telnet</td>
<td></td>
<td>&lt;2s</td>
<td>&lt;250ms</td>
<td>N/A</td>
<td>&lt;1Kbps</td>
<td>&lt;1Kbps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broadcasting</td>
<td></td>
<td>2-5s</td>
<td>&lt;150ms</td>
<td>&lt;100ms</td>
<td>56-64K</td>
<td>60-80Kbps</td>
<td>0.1%</td>
<td>&lt;0.1%</td>
</tr>
<tr>
<td>Video Broadcasting</td>
<td></td>
<td>2-5s</td>
<td>&lt;150ms</td>
<td>&lt;100ms</td>
<td>1.2-1.5mbps</td>
<td>&lt;0.001%</td>
<td>&lt;0.001%</td>
<td></td>
</tr>
<tr>
<td>Audio on Demand</td>
<td></td>
<td>2-5s</td>
<td>&lt;150ms</td>
<td>&lt;100ms</td>
<td>32-448Kbps</td>
<td>&lt;0.1%</td>
<td>&lt;0.001%</td>
<td></td>
</tr>
<tr>
<td>Web Browsing</td>
<td></td>
<td>2-5s</td>
<td>&lt;400ms</td>
<td>N/A</td>
<td>&lt;30.5K</td>
<td>&lt;30.5K</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FTP</td>
<td></td>
<td>2-5s</td>
<td>Medium</td>
<td>N/A</td>
<td>High</td>
<td>High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Video on Demand</td>
<td></td>
<td>&lt;150ms</td>
<td>1.5Mbps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Audio Conferencing</td>
<td></td>
<td>&lt;150ms</td>
<td>&lt;400ms</td>
<td></td>
<td></td>
<td>&lt;1%</td>
<td>&lt;1%</td>
<td></td>
</tr>
<tr>
<td>Video Conferencing</td>
<td></td>
<td>&lt;150ms</td>
<td>&lt;400ms</td>
<td></td>
<td></td>
<td>&lt;0.01%</td>
<td>&lt;0.01%</td>
<td></td>
</tr>
<tr>
<td>Videophony</td>
<td></td>
<td>&lt;100ms</td>
<td>&lt;400ms</td>
<td>H.320 64-1920k</td>
<td>80k-2Mbps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOIP</td>
<td></td>
<td>&lt;150ms</td>
<td>&lt;30ms</td>
<td>G.711 64K</td>
<td>21-320kB</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
<td></td>
</tr>
<tr>
<td>Audio Graphics conferencing</td>
<td></td>
<td>&lt;150ms</td>
<td>&lt;400ms</td>
<td>9.6-19.6kbps</td>
<td></td>
<td>&lt;1%</td>
<td>&lt;1%</td>
<td></td>
</tr>
<tr>
<td>Ecommerce Applications</td>
<td></td>
<td>&lt;4s</td>
<td>&lt;10 K</td>
<td>NA</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

*Missing Values are not available in Literature*

IV. IMPLICATIONS

The above literature review suggests that there are various VANET applications that have different requirements in terms of QoS metrics or resources which can be provided by different routing protocols. The efficacy of these protocols varies under different scenarios i.e sparse and dense. Table 2 gives us tabulated information as far as various routing protocols are concerned along with QoS metrics studied and scenarios taken into consideration. Table 3 is providing information regarding applications handled by different protocols at ease. The applications like online games, e commerce websites, live video streaming require more secure and hard QoS constraints in terms of delay, jitter and response time as compared to video/audio streaming. Another set of applications like email, FTP, telnet are not bounded by such constraints. Different protocols have been surveyed and they consider different QoS metrics at a time like AODV improves PDR, reduces delay whereas PBR works on link lifetimes, MURU works on expected degree disconnection (EDD), OLSR and GRP work very well for greater network sizes, IGRP specifically works for the cluster of nodes at intersections in urban scenario, VOA improves bandwidth and has been applied to highway scenario now it can be applied to city environment and so on.
TABLE II - COMPARATIVE STUDY OF THE DIFFERENT ROUTING PROTOCOLS BASED UPON THE DIFFERENT QoS METRICS VIZ A VIZ SOME STANDARD PROTOCOLS LIKE AODV, DSR, GPSR, OLSR

<table>
<thead>
<tr>
<th>Protocol</th>
<th>In Comparison To</th>
<th>QoS Metrics Studied</th>
<th>Scenarios</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBR</td>
<td>AODV</td>
<td>Improves Lifetime of link, Increases Route Length, Dropped Packets Ratio Less</td>
<td>Urban</td>
<td>Can lead to smaller throughput and higher energy consumption</td>
</tr>
<tr>
<td>GVGrid</td>
<td>GPCR</td>
<td>Maintains a route with long lifetime</td>
<td>Urban</td>
<td>Does not guarantee BW or link Delay</td>
</tr>
<tr>
<td>MURU</td>
<td>AODV, DSR, GPSR</td>
<td>EDD (A metric to know the expiration time of route), Improves Data Delivery Ratio, Reduces Lower Delay</td>
<td>Urban</td>
<td>Due to rectangular broadcast areas, may be susceptible to local optimums</td>
</tr>
<tr>
<td>IGRP</td>
<td>GPSR, OLSR, GPCR</td>
<td>Works on Transmission Range, Reduces Error Rate</td>
<td>Urban</td>
<td>Delay increases with the increase in network density. Does not choose routes which have very high number of nodes result in network contention</td>
</tr>
<tr>
<td>VOA</td>
<td>AODV, DSR</td>
<td>Improves Bandwidth, Reduces Routing time, Improves Response Time</td>
<td>Highway, can be implemented on city scenario</td>
<td>Response time little less when relative speed is high</td>
</tr>
<tr>
<td>QS-AODV</td>
<td>AODV</td>
<td>More Accuracy in estimating Delay</td>
<td>Mobile Adhoc Networks</td>
<td></td>
</tr>
<tr>
<td>FSR</td>
<td>GSR</td>
<td>Reduces consumed Bandwidth, Improves Delivery Ratio</td>
<td>Highway</td>
<td>Entire topology exchange, consumes a considerable BW</td>
</tr>
<tr>
<td>DeReQ</td>
<td>AODV</td>
<td>Maximum Reliability, Reduces link Delay</td>
<td>Urban</td>
<td>Mainly relies on vehicles mobility that is highly dynamic</td>
</tr>
<tr>
<td>RBF-H</td>
<td>SBF-H</td>
<td>Reduces packet delay, reduces packet loss rate</td>
<td>Highway and urban traffic</td>
<td>Packet loss caused by buffer overflow which is unavoidable</td>
</tr>
<tr>
<td>CAR</td>
<td>GPSR</td>
<td>Improvement in PDR, Reduces Average packet delays</td>
<td>Highways</td>
<td>Path discovery phase lead to overhead, cannot adjust with different sub paths when traffic environment changes</td>
</tr>
</tbody>
</table>

TABLE III - PROTOCOLS THAT ENSURE QUALITY OF SERVICE ALONG WITH THE EASE OF HANDLING APPLICATIONS

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Applications easily handled by Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBR</td>
<td>Real time Data Dissemination in urban</td>
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<tr>
<td>GVGrid</td>
<td>Email, FTP, Telnet</td>
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<td>MURU</td>
<td>Multimedia streaming</td>
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<tr>
<td>IGRP</td>
<td>Real time data dissemination</td>
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<td>VOA</td>
<td>Video streaming</td>
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<td>QS-AODV</td>
<td>Multimedia Applications</td>
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<tr>
<td>VADD</td>
<td>FTP, Email, Telnet</td>
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<td>DeReQ</td>
<td>Multimedia streaming, Real Time Data Dissemination</td>
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<tr>
<td>RBF</td>
<td>Video Streaming</td>
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Attention needs to be drawn towards efficacy of various VANET routing protocols for delay sensitive applications such as 2D video streaming, online games. The authors are working to propose a solution which has optimum performance for most of the applications in both urban and highway scenario in VANETs by developing a hybrid protocol which will be sufficing the requirements for network applications by applying the existing Network Coding technique to improve the quality of service. Focus is to develop a routing protocol which can satisfy resource requirements of most of the video streaming applications. Response time of different applications shall be collected so that improvement can be evaluated in applications. Qualitative comparative data regarding different protocols shall be worked out for two or more applications. We shall vary our Constant Bit Rate and Variable Bit Rate for different video streaming applications while studying their Packet Delivery Ratio, End to End Delay, Error Rate, loss rate and so on. Focus shall be on developing a hybrid protocol for improving QoS in video streaming applications.
V. CONCLUSION

Various routing protocols which are meeting the requirements of different applications running on VANET nodes have been studied. The routing protocols associated with multimedia streaming, video streaming, video conferencing, live video streaming have been reviewed in this article. The performance of applications has been evaluated in terms of PDR, delay, jitter, bandwidth consumption and response time. Certain hybrid protocols may be designed by combining two features of different routing protocols like estimating bandwidth and improving the bandwidth. PBR works on estimation of link life time which in turn reduces route breakage and improves route stability and reduces retransmissions and delays caused. Not much work is available in literature towards the specificity of application running on VANET according to the protocols especially more delay sensitive applications. Future research may focus on the simulation of different applications and their performance can be evaluated under different scenarios and mobility models. The performance of 2D, 3D video streaming applications in terms of QoS metrics with existing and proposed protocol shall be analyzed and compared. Qualitative comparative study of proposed hybrid protocol for lower speed limits, intersections, traffic lights etc. that can affect the performance of protocol in vehicular networks.

REFERENCES

[29] S Basagani et al,”A Distance routing effect Algorithm for Mobility (DREAM), Proc 4 th Annual ACM/IEEE Int. Conf. Mobile computing and Networking, MOBICOM ’98, Dallas, TX, USA 1998 pp 76-84