Mobility-aware cross layer based reliable routing protocol for improved data dissemination in VANETs

Shaik Shafi, D Venkata Ratnam

Abstract*: *Vehicular Ad-Hoc network (VANET) is a highly dynamic decentralized wireless communication network and becoming promising transportation system due to rapid extension of safety and multimedia applications. However, both the applications demands fast and successful data dissemination to the destination nodes, design of reliable routing against intrinsic behavior of VANET is still challenging issue. Towards this, latest researches concentrated on mobility metric along with shortest path or minimum number of hops and showed improved performance in data transmission. Thus, in this paper, a new Mobility aware Cross layer Based Reliable Routing Protocol (CBRRP) is proposed for efficient data dissemination in the network. For optimal route selection, the proposed CBRRP applies several critical parameters, like link reliability factor, residual energy and neighbor node weight factor to Route Request (RREQ) packet and mobility metrics (relative velocity and distance) to Route Reply (RREP) control packet in the direction of destination vehicle. The performance of proposed CBRRP is compared with recent existing cross layer based routing protocol using Network Simulator (NS)-2. The simulation results clearly demonstrate that the proposed CBRRP offers lower energy consumption, end to end delay with improved link reliability for different urban traffic scenarios over existing approach.

Keywords: Cross layer, Multimedia applications, Mobility metrics, Reliability, VANET.

I. INTRODUCTION

The rapid advancements in the area of wireless data communication methods, led researchers foresee to put efforts on enhancing safety and the efficiency of the transportation services. In particular, Vehicular Ad-hoc Network (VANET) is a special kind of self-organized short-range wireless communication network which is different from Mobile Ad-Hoc network (MANET) due to typical features like intermittent connections and high mobility of vehicles. VANET is considered as the prominent technology aims at different applications starting from emergency to multimedia services. Typical emergency service is classified as road safety and traffic management prevents accidents. On the other side, the multimedia applications include live streaming of audio/video data [1-3]. Both applications depend on proficient and timely propagation of data within the network. This can be achieved by the use of vehicle-to vehicle multi-hop communications. Under different traffic scenarios, such as during light and heavy traffic, the mobility of vehicles results in sporadic connectivity. Thus the wireless link between two vehicles may often disappear while exchanging data. Such characteristics often bring new challenges in the dissemination of data and wireless technologies [4]. Most of the existing data dissemination approaches for VANETs, are categorized into position-based and topology based routing protocols designed using some specific characteristics like position and relative distance of mobile nodes respectively. In position-based routing protocols, data is transmitted directly from the source to the destination without any route identification. Thus, each forwarding mobile node assumes to know its current location through GPS, positions of neighboring nodes by periodic broadcasting of Hello messages and destination using position service protocol [5]. In realistic scenarios the position based protocols are not suitable, as networking of data packets is strictly related to time. In addition to this, the position-based routing protocol suffers from high communication overhead as vehicles continuously need to update positions of their neighbors in the routing table for data dissemination On the other side, Topology – based routing protocols aims to identify the route between the source and destination before the data transmission initiated. The topology based routing protocols are mainly categorized into two types such as proactive or table driven routing, reactive or on demand routing. Pro-active routing attempts to establish route to destination based on entire topology information by updating routing table at each and every node. Therefore, in highly dynamic networks routing table cannot be updated rapidly to adjust to the topology changes. Thus, leads to huge consumption of bandwidth for route discovery due to the usage of large amount of control messages for routing table entry. Reactive routing tries to set up a complete route between source and destination using flooding (broadcasting) mechanism. However, the established route will be broken due to highly dynamic topology of VANETs. Thus both reactive and proactive routing protocol suffers from scalability issues in large scale and highly dynamic networks.

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In addition, these traditional schemes are strictly based on single OSI layered approach and also optimize QoS metrics such as End to End delay and Packet Delivery ratio without considering all protocol layers For example, single layer protocols do not consider explicitly the wireless channel conditions whether the channel is capable of supporting the communication. Thus leads to poor performance in terms of increase in network congestion and interference due to retransmission requests from other nodes.

Therefore, to overcome these issues requires the exchange of information among different layers of the OSI model. In addition, due to the highly dynamic topology of VANETs, the wireless connection time between two vehicles is very short. Authors in [6] proposed a cross-layer based routing protocol named Signal Strength Assessment Based Route Selection for OLSR (SBRS-OLSR), to improve the system performance. In which the link connectivity is improved by exploring the information among Physical, MAC and network layers. In particular, SBRS-OLSR maintains the routing information through selection of multipoint relays (MPRs), where only the selected relay nodes transmit topological information same as OLSR. However, MPR selection process is based on residual link lifetime and is defined as the amount of time a node remains in another node's transmission range. Thus can provide a better routing path that improves throughput and delay performance. On the other side, the SBRS-OLSR is not tested under high density and mobility scenarios. Based on the MAC and network layer integration, C. Yufeng et al., proposed a cross-layer Ad hoc On- Demand Multipath Distance Vector (R-AOMDV) routing protocol [7]. Route selection in R-AOMDV depends on the combination of both hop-counts and retransmission counts at MAC layer. The main objective of the protocol is to improve link quality in urban VANET by considering the shortest path based on retransmission count, thus suitable for both highly dense and meager networks. However, during high vehicle speed R-AOMDV shows considerable packet loss and delay. Also due multipath routing mechanism it also exhibits broadcast storm problem during high vehicle scenario.

Authors in [8] presented another Cross-Layer routing protocol designed based on MAC and Network layer integration, named as Cross-Layer Broadcast Protocol (CLBP). Route selection in CLBP depends on identifying the most adaptive relay node using mobility metric (velocity) with channel conditions and positional information of the nodes. Thus CLBP shows significant improvement in packet loss due to consideration of channel conditions for packet routing. However, CLBP shows a considerable amount of increase in bandwidth consumption if the positioning system fails, since the vehicles need to broadcast their position for packet routing. [9] W.-H. Chen et al., have proposed cross-layer cooperative routing (CLCR) protocol to maximize throughput by exchanging the information between the MAC layer for connection time and Physical layer for Signal to Noise ratio. Thus improves the channel reliability. However, there is no significant improvement in delay and route cost. This is due to the route discovery mechanism in CLCR which is similar to AODV results into broadcast storm issue thus requires more transmission power packet routing. On the other hand, it is observed that there is considerable improvement in terms of reduced packet loss ratio with improved throughput in CLCR over the non cooperative scheme. This is due to the selection of cooperative relay vehicle by considering channel conditions as mentioned. Authors in [10] have proposed another protocol named as Cross-layer weighted position-based routing (CLWPR) through the information exchange between physical and MAC layers. Also it makes use of positional information for next hop selection for packet routing. Every node calculates Signal to Interference pulse Noise Ratio (SNIR) by considering the information at Hello beacon such as node velocity, position, error rate etc. to determine the weight of available next path. Lastly, the hop with minimum weight is selected for data dissemination. Further, usage of positional information and obtained SNIR results in improved packet reception rate and minimizing end to end delay in sparse networks only Authors in [11] have presented a new efficient routing protocol, named as Multi-hop cross-layer decision based (MHCLD). It exploits parameters of Physical and MAC layers such as SINR and cached information to improve delay performance. MHCLD includes two mechanisms. First one is neighbor selection with Channel Quality Indicator (CQI) measured in terms of SINR and second is routing. Based on CQI and routing information, data transmission takes place. However, under high dynamic topology, the performance of MHCLD degrades. R. Oliveira et.al. [12], proposed a cooperative solution with adaptive relay node selection between source to destination to improve safety and traffic efficiency applications. The main aim of the approach is to address broadcast storm and frequent link failures during high and low vehicle densities through dynamic adjustment of beacon periodicity. Upon extensive simulations, authors have compared the performance of proposed protocol with well known beacon based and beacon less routing approaches [13] [14] in VANET with regards to safety applications. Simulations results show that proposed protocol maintains high delivery ratio and low average delay under different traffic scenarios. The authors in [15] proposed a multipath routing protocol in VANETs, wherein three critical factors, number of hops, mobility parameters and radio transmission rate are used for route selection. Simulated results shows, the performance of the proposed multipath routing approach is promising. Authors in [16] presented routing scheme based on cross layer paradigm, for safety and multimedia services. The route selection is based Neighbor set Ratio algorithm, identifies relay vehicles with least neighboring vehicles. Thus reduces unnecessary flooding of control packets for route discovery results into less route cost and overhead. However, link estimation is the major drawback in AODV leads to frequent path breaks.

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In the similar lines, authors in [17][18] have proposed routing schemes for proficient networking of data packets. Further, to support infotainment services such as safety information dissemination and audio/video streaming in VANETs, authors in [19] have proposed An Enhanced version of AODV (En-AODV) routing protocol.En-AODV exploits cross-layer information such as link quality at the network.

In summary, the aforementioned Cross Layer based schemes, majority of the works used hello packets to determine link quality and hop count for proper route selection. However, in high vehicle density scenarios, due to periodic broadcasting nature of routing schemes, there is a high probability of collision with other packets. Thus, affects the packets reception ratio and further, difficult to estimate Quality of Service metrics (link quality, hop count) with available less number of hello packets. Towards this, we propose a novel Mobility aware Cross layer Based Reliable Routing Protocol (CBRRP) to reduce broadcast storm problem through selection of critical parameters like, link reliability factor residual energy and mobility metrics (relative velocity and distance)

II. PROPOSED WORK

In this section, we illustrate the main idea of our proposed scheme, Cross layer Based Reliable Routing Protocol (CBRRP) for improved data dissemination in VANETs. To this end, CBRRP has two major goals to achieve: (i) Route discovery (ii) Route maintenance. In addition, the proposed CBRRP operates at network layer for routing function; however it is essential to consider cross layer aspect, for cooperation between the physical and network layers to choose the most reliable path among the available options. This is obtained by recording physical layer measurement such as received signal strength value based on send time field at the routing level to approximate a given link lifetime. Each and every vehicle maintains this information in its routing table. Then if a proper route is available, data packets are sent through the route.

A. Route discovery in CBRRP

When a vehicle desires to send multimedia packets to another distant vehicle, first it checks availability of a valid route to this vehicle in its routing table, if the route is present then networking of the packets takes place, otherwise initiates a new route. This includes broadcasting a new RREQ packet to all its neighbors in the same manner as in AODV. The new RREQ field format used in our CBRRP contains 4 extra fields in addition to those used by AODV, as shown in Table I.

The first field illustrates Send Time (Ts) of a RREQ packet, which helps in calculating the delay time between two nodes. The calculated delay time is recorded at each intermediate vehicle routing table. The second filed describes the least possible neighbors to a particular vehicle, helps RREP packet to choose least hop path in reverse phase explained in the next section. Once the new RREQ packet disseminated to its final destination, a RREP packet is sent back to the originator vehicle among available routes with less delay time. The RREQ packet of CBRRP consists of IP address and sequence number of transmitting node (Vehicle). Further RREQ includes most recently forwarded destination, hop count to the destination (final receiver) and sequence number of destination to the source

Table I. Route Request packet new field format

Type 1=RREQ	Flags	Reserved	Hop Count
Route Request Packet Broadcast ID			
Receiver IP Address			
X-Position		Y-Position	
Originator IP Address			
Originator Sequence Number			
Speed		Direction	
Send_time		**Delay Time**	
Energy Consumption		**Neighbor node weight factor**	
Reliability factor			

B. Lifetime calculation and addition of mobility metric:

To address the link failure during message dissemination in VANET, estimation of link life time is essential. Towards this we propose adding of mobility metrics such as Relative velocity (V_R) and Residual distance (R_d) into RREP packet dedicated to the VANET topology. Both velocity and distance parameters contributes in estimating life time and link failures respectively. Thus, addition of these VANET-dedicated parameters to RREP packet ensures to have a stable Vehicular Ad hoc Network.

Table II. Route Reply packet new field format

RREP	Flags	Reserved	Hop Count
RREP Broadcast ID			
Receiver IP Address			
Receiver Sequence Number			
Originator IP Address			
Originator Sequence Number			
Mobility metric			
Route Life Time using Delay time			

The residual distance (R_d) between two vehicles (sender and receiver) is calculated as

$$\mathbf{R_d = V_R . T_d} \qquad \textbf{(1)}$$

Where V_R represents Relative velocity and T_d represents communication time. Further V_R can be written as

$$\mathbf{V_R = V_S - V_r} \qquad \textbf{(2)}$$

In the above equation, V_s and V_r represents velocities of sender and receiver vehicles respectively. As said, the calculated delay time is compared with the minimum lifetime (Threshold value) of the link between any two vehicles and is considered as half of the radio range of the transmitter node (vehicle) as Lifetime (L_t) < $R_T/2$. Every relay or intermediate vehicle compares the calculated delay time with threshold value (L_t).

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The so calculated delay time or lifetime satisfying the condition, data packet is forwarded else dropped. Thus route error rate comes down greatly and improves percentage of packet delivery ratio. Delay parameter is slightly decreased when compared to existing En-AODV by reducing the unnecessary flooding (broadcasting) of control packets during link breaks as each relay vehicle contributed in the route discovery phase. Route maintenance is the second phase of challenge in CBRRP, where the established route must be maintained irrespective of topology changes. Thus, an efficient reaction is preferred to return the broken link(s). Such a link failure is identified through networking of periodic hello messages among neighboring vehicles. Initiation of the entire process of route maintenance is started only if the remaining lifetime of the route is lower than a given threshold, else the sender vehicle will set up a new route to communicate with the destination.

C. Delay time and neighbor node weight factor estimation through Send Time (T_s) field format.

The main metric used to choose a route between two vehicles is, number of hops. However, due to the VANET characteristics, proper route selection is interrupted frequently. In CBRRP, due to the addition of Send Time field, selection of the most stable route is assured. This is achieved by calculating link lifetime estimation based on delay time calculation using equation 3.

$$T_{di} = T_{ri} - T_{si} \qquad (3)$$

Delay time (Tdi,), indicate the amount of time taken by Route Request (RREQ) packet to reach (i+1)th vehicle, transmitted by ith vehicle. Receive Time (T ri), indicate the amount time taken to receive RREQ packet by (i+1)th vehicle, transmitted by ith vehicle. Send Time (Tsi), indicate the time at which the RREQ packet is sent by ith vehicle to nearest one hop neighbor (i+1)th vehicle and it is recorded in send time field of new RREQ packet format as given.

If the delay time (T_d) is more, indicates that the vehicles are away from their radio coverage (R_T). Thus link life time is very less and leads to link failure. Therefore in the reverse process, the return route opted by RREP is not indeed same as the route employed by RREQ. Instead RREP packets sent back by considering calculated and recorded least possible hops and less delay time at each and every intermediate vehicle. Then source vehicle choose a vehicle as adaptive relay with less Route Reply (RREP) packets and it updates the path in routing table at each vehicle at every instant. Except at the destination vehicle the above process is repeated for relay selection. Therefore the number of hops to the destination is reduced to forward the data. Thus leads to reduced routing cost in terms of usage of less number of control packets for route discovery and the reduced delay.

D. Calculation of long duration links through reliability factor (R_L):

A link between two moving vehicles can be formed by sensing radio transmission range (R_T) and relative distance (D) between them as $D \leq R_T$. In CBRRP the links are created and maintained by periodical exchange of beacon messages. The link duration is specified by the number of beacon messages received. Let at time instant t_s, vehicle V_i receives a RREQ from V_j through a unidirectional link between them if it satisfies $D \leq R_T$. In order to calculate and improve the link duration, consider the mobility metrics such as relative distance and velocity to the VANET topology. The first parameter allows in extending the path life time, while second reduces the link breaks. Thus addition of these parameters establishes long duration links in the network. The mathematical expression to identify the link duration through reliability factor associated between the vehicles is given by

$$\mathbf{R_L} = \frac{1}{n} \sum_{j=0}^{n-1} (T_{dij} - T_{ai})^2 \qquad \mathbf{(4)}$$

Where T_{dij} is delay time of j^{th} neighboring vehicle of *i* and T_{ai} is an accumulated delay times of the vehicle *i* in the latest period. From equation (2), reliability (R_L) measures the lifetime of the link. If R_L is less, then the distance between two vehicles is more. Further it leads to link break, thus duration of the link decreased and effects networking data packets.

E. Calculation of Residual Energy (RE):

At the beginning each and every node has some initial energy and starts discharges for every packet transmitted and received. Therefore, at any particular time the initial energy of a node gets discharged. The residual energy of a node is now defined as, the amount of energy available in a node after receiving or transmitting packets at a precise time. Networking of packets will be stopped if the calculated residual energy at particular a node is too low to transmit to destination.

For example the residual energy of a particular node 'i' at time 'T' sec is given by equation (5) as shown.

$$\mathbf{RE_{i(T)} = E_{i0} - E_{ci(T)}} \qquad \mathbf{(5)}$$

Where E_{i0} is initial energy at node 'i' and $E_{ci\,(T)}$ termed as energy consumption at node i up to T sec. Energy consumption by a each node for T seconds is calculated using the expression shown in (6).

$$\mathbf{E_{ci\,(T)} = Et(p, i) + Er(P', i)} \qquad \mathbf{(6)}$$

Where Et(p,i) and Er(p',i) represents amount of energy required for node i for networking of packets P and P' respectively. P and P' indicate the number of packets transmitted and received by node 'i'.

F. Routing Table field format of the proposed algorithm:

The proposed CBRRP algorithm uses the following message types: beacon messages, Route Request (RREQ) messages, Route Reply (RREP) messages and Route Error (RERR) messages. In-general beacon messages are broadcasted by any node, but in the proposed algorithm the nodes in the main route send beacon messages to nearest one hop neighbors based on Neighbor Set ratio[16].

Whereas, RREQ and RREP control messages are used in the route discovery process. In case of route maintenance and restoration phase RERR message is used. Table 3 shows the routing table field format, which has more fields than existing En-AODV and AODV routing tables. Upon receiving RREQ, RREP, and RERR messages the routing table is updated.

Table III. CBRRP-Routing table field format

Destination-ID
Direction to Destination
Next Node Distance
Hop-Count
Sequence Number
Reliable factor using Delay time
Residual Energy

The purpose of each field is illustrated below. The Destination ID (Dest ID) field consists of the destination vehicle ID. The distance field stores the distance value between two neighbor vehicles; normally it is the radio range of the vehicle or node and is ranges from 1 to 250. Another filed named such as Hop-Count shows the hop count information to the destination. Sequence number and Lifetime filed formats indicates sequential numbers and route lifetime respectively. Residual Energy stores the remaining energy of a node.

Algorithm I: Route discovery phase between Source and Destination

1. ***Initialize***
2. ***Procedure: Route discovery from source to destination***
3. ***Source node (S) checks path to destination node (D)***
4. ***If path is available***
5. ***go to line 9***
6. ***else***
7. ***go to line 3***
8. ***end if***
9. ***generate modified RREQ,***
10. ***then***
11. ***broadcast RREQ to nearest neighbor***
12. ***check for destination***
13. ***if the neighbor is destination***
14. ***accumulate all RREQs***
15. ***Compute link lifetime choose reverse path with max*** L_T
16. ***then acknowledge with RREP***
17. ***else***
18. ***calculate delay time*** T_d
19. ***if*** $T_d < R_T/2$
20. ***store the value in routing table***
21. ***else***
22. ***drop RREQ, go to line 11***
23. ***end if***

G. Route maintenance and restoration in CBRRP:

The second challenge in CBRRP is route maintenance and restoration of the recognized route since in urban VANET, high speed of vehicles results into a sudden change of network topology. Thus, a fast and efficient reaction is needed to restore the broken link(s). In an existing scheme such as AODV and EN-AODV, the local repair procedure is the same as AODV, in which source vehicle broadcasts an RREQ message to find the destination as and when finds a link failure. If no destination is available, it then broadcasts a RERR message back to all the vehicles that are reliant on the broken link. Upon receiving RERR message, concerned vehicles delete the route of the broken link and restart the route discovery procedure.

Algorithm II: CLARR-Route maintenance phase:

1. ***Start route repair***
2. ***Check the delay time of the current vehicle***
3. ***If*** $T_d > R_T/2$ ***(route failure) then***
4. ***Current vehicle checks for alternate route in its routing table***
5. ***end***
6. ***If exists***
7. ***Send data by reconfiguration of the route then***
8. ***go to line 19***
9. ***else***
10. ***estimate distances to source and destination from current vehicle***
11. ***If distances is < route length/2***
12. ***Broadcast RREQ for route reconfiguration then***
13. ***go to line19***
14. ***else***
15. ***send RERR to source vehicle then***
16. ***go to line 11***
17. ***end***
18. ***end***
19. ***finish route repair***

In the proposed approach, when a successor vehicle detects a link failure, then it sends an RREQ message toward the direction of the destination instead all the nearby neighboring vehicles. Thus reduces the routing message overhead. As discussed in the previous section, when a source vehicle broadcasts CBRRP- RREQ message to its one-hop neighbors, it (current vehicle) first calculates the link lifetime between it (neighbor) and the source vehicle based on information(Direction, send time and velocity) available in RREQ filed format. Then the neighbor vehicle creates/updates the direct route based on the calculated link lifetime value. Later, it compares the calculated link lifetime value with the saved value in CBRRP-RREQ message and opts the one with high lifetime, and the new value is now saved in RREQ message.

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The process is repeated for multiple RREQs till destination. Then new CBRRP- RREP message will be sent back to the source vehicle and set the link lifetime value. When source vehicle receives multiple new RREPs for one RREQ, then it will choose the route based on the maximum lifetime value of route lifetime field among all incoming RREPs. In this way, the most stable route to the destination vehicle is selected. Then, once a source vehicle selects the destination with maximum lifetime and minimum NSR among the available routes based on the information available in the routing table entries or in a reactive manner, the data packet is forwarded. If there is no suitable vehicle for networking of data, route repair procedure comes into the procedure.

III. SIMULATION ENVIRONMENT

As our main objective is to provide information dissemination in VANET for safety applications, thus we majorly focus on measuring the following performance metrics. The performance of proposed CBRRP is evaluated using a Network simulator (NS)-2.34, an object oriented event driven simulator includes different routing protocols for wireless Network and Animator (NAM) for visualization of the vehicles. In this work we employed different urban traffic scenarios with a vehicle density 40 & 100 and speed ranges from 20Km/hr to 100km/hr. For every scenario, we employed 2500m*2500m fixed topology area for simulation. At the beginning, vehicles are randomly distributed in the simulation area. Each vehicle uses a unidirectional antenna with a radio range of 350m. To test the dynamic nature of the proposed CBRRP, pause time in the simulation is set to null. The traffic sources start at random times from the beginning of the simulation and stay active throughout.

Table IV. CBRRP-Simulation Parameters

Simulation Parameter	Typical Values
Channel Type	Wireless
Dimensions(m^2)	2500*2500
Mobility model	RWP (Random Waypoint)
Vehicle Speed (Km/hr)	20,40,60,80,100
Simulation Time(sec)	300s
Number of vehicles	100
Propagation Model	Two-Ray Ground
MAC	802.11p
Radio Transmission Range(m)	350m
Protocols Employed	En-AODV, CBRRP
Bandwidth	2Mbps

In order to see the best results total of 10 independent simulation runs are performed and considered the average best result. In addition tools named as Set-dest and cbr-gen is used to generate random motion and for random data communication respectively. Towards this the source vehicle generates Constant Bit Rate (CBR) traffic and generates 4 packets/sec with each packet size is of 512. The remaining simulation metrics are listed in the Table 4.The simulation time is set to 300s. The main intend of simulations is to assess the performance differences of the Proposed CBRRP and existing AODV and En-AODV routing Protocols for different vehicle velocities.

IV. RESULTS AND DISCUSSION

In this section a comparative performance analysis of the proposed CBRRP and existing Enhanced- AODV is carried out. The performance is compared in terms of reliability, throughput, energy consumption and end to end delay for varying vehicle velocities. Figure 1, 2, 3 and 4 show the effect of varying vehicle velocity on reliability, throughput, energy consumption and end to end delay respectively. In all these cases, vehicle velocity is varied from 20(Km/ph) to 100(Km/ph) such as 20,40,60,80,100. Vehicle density is taken as 40. Figure 1, shows lower Energy Consumption of CBRRP compared to En- AODV for varying vehicle velocities and is about 3% less in CBRRP when the vehicle velocity is 100km/hr. The reason behind this is, in CBRRP reliable paths are selected considering nodes higher residual energy and higher received signal strength from the next hop. Thus, reduces link breaks and saves node battery power by minimizing re routing. Therefore, more packets will be delivered per second in CBRRP over existing En-AODV due to optimal route selection.

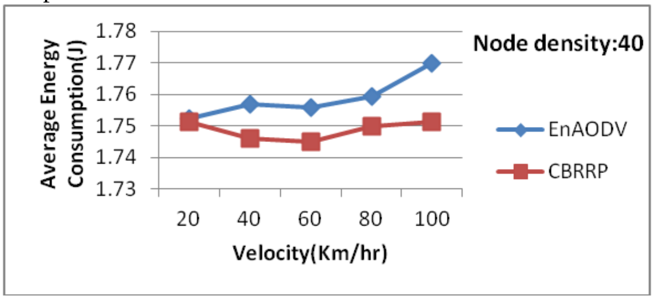

Fig.1. Impact of different velocities on Energy Consumption.

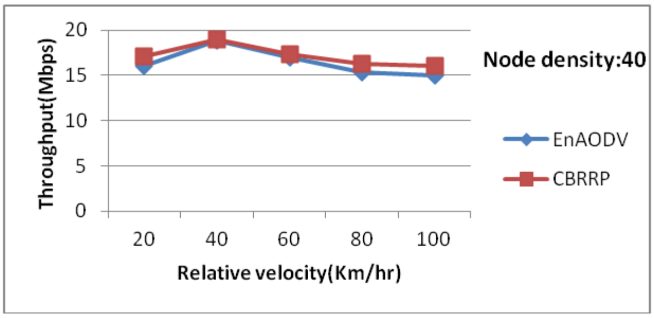

Fig.2. Impact of different velocities on Throughput.

Fig.2. shows that with the increase in vehicle speed the throughput in proposed CBRRP and existing En-AODV increases for small rise in velocity from 20-40 (Km/hr) with node density equal to 40.

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This is due to considerable increase in mobility of the vehicles, at which loss of connectivity is less. Therefore, number of data packets disseminated to destination is increasing over simulation time. Further, as vehicle speed increases from 40-60-80-100, vehicle movement becomes faster that leads in loss of connectivity and degradation in the throughput. However, the number of packets delivered in line to destination per simulation time is 6% higher in Proposed CBRRP than En-AODV during high mobility scenarios. This is due to selection of reliable paths by considering residual energy and mobility parameters in CBRRP. Thus, the packets delivered per second are more in case of highly mobile scenario as link breaks are less in CBRRP.

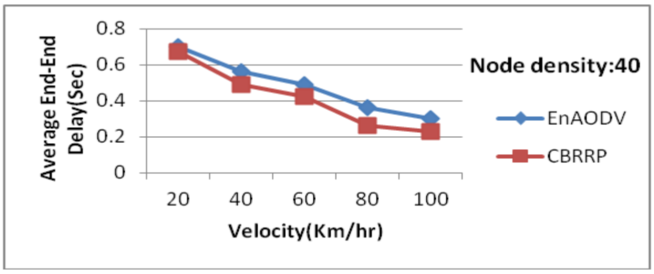

Fig.3. Impact of different velocities on packet delay.

Fig.3. shows that with the increasing vehicle velocity end to end delay decreases in both CBRRP and En-AODV. In general during high mobility scenarios the connectivity between the vehicles is poor, however in both CBRRP & EN-AODV routes are selected based on link lifetime estimation, thus reduces route error rate. So, time taken for data packets to reach the destination is decreases. Further, CBRRP includes residual energy and mobility parameters of the vehicles along with link lifetime for route selection, offers 23% faster in networking of data packets than En-AODV.

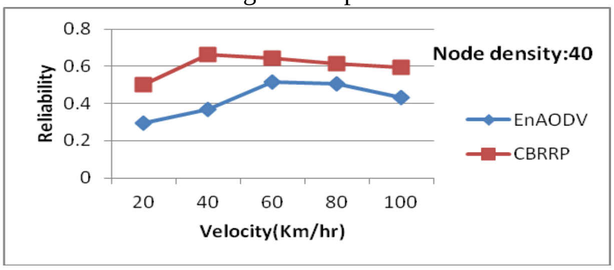

Fig.4. Impact of different velocities on Reliability.

Fig.4. shows that with the increase in vehicle speed the reliability in proposed CBRRP and existing En-AODV increases for small rise in velocity from 20-40 (Km/hr) with node density equal to 40. This is due to considerable increase in mobility of the vehicles, at which loss of connectivity is less. Further, as mobility of vehicles increases from 40-60-80-100, vehicle movement becomes faster that leads in loss of connectivity and degradation in the throughput. However, the Proposed CBRRP offers 27% higher reliability than En-AODV, as CBRRP selects stable paths by considering accumulated link reliability along with energy consumption and mobility parameters. Thus, the ratio of successfully received data packets at the receiver to that of sum of data packets received and lost is high in CBRRP. In general reliability is denoted by R and lies between 0 and 1, if R=1 shows the best case.

Fig.5.shows the impact of varying vehicle velocity on energy consumption in proposed CBRRP and existing En-AODV with vehicle density as 100. In both the schemes cases, vehicle velocity is varied from 20(Km/ph) to 100(Km/ph) such as 20,40,60,80,100 and shows lower Energy Consumption of CBRRP compared to En- AODV. The reason behind this is, in CBRRP reliable paths are selected by considering higher residual energy of the vehicle and higher received signal strength from the next hop. Thus, reduces link breaks and saves node battery power by minimizing re routing. Therefore, more packets will be delivered per second in CBRRP over existing En-AODV due to optimal route selection. In addition, figure 1, 5 shows, the energy consumption is slightly increases as number of vehicles increases in the network, however proposed CBRRP has superior performance over existing En-AODV as mobility increases

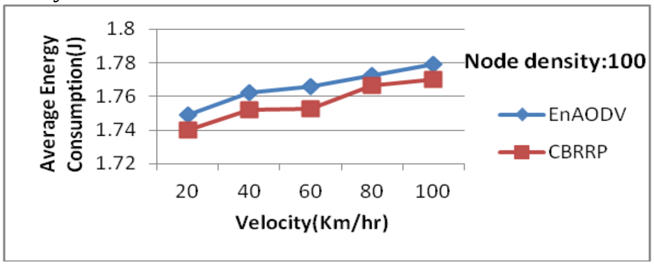

Fig.5. Impact of different velocities on Energy Consumption.

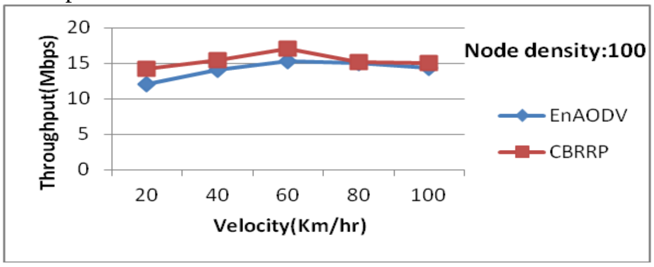

Fig.6. Impact of different velocities on Throughput.

Fig.6. shows that for high vehicle velocities throughput is decreasing in both proposed CBRRP and already existing En-AODV, with node density equal to 100. This is due to loss of connectivity during high mobility scenarios. However, the throughput in Proposed CBRRP is 4% greater En-AODV, this is due to selection of reliable paths by considering critical factors like residual energy and mobility parameters. Thus, the packet delivered per second is more in case of highly mobile scenario as link breaks are less in CBRRP. In addition, figure 2, 6 shows, the performance of throughput of CBRRP is comes down to 4% from 6% for different vehicle densities, 40 and 100. This is due to increase in number of vehicles and results into increases in number of connections in the network. Therefore, packets delivered to destination per simulation time increases. On the whole proposed CBRRP has superior performance over existing En-AODV as mobility increases. Fig.7. shows impact of high vehicle velocity on end to end delay and is decreases in both CBRRP and En-AODV.

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In general during high mobility scenarios the connectivity between the vehicles is poor, however in both CBRRP & EN-AODV routes are selected based on link lifetime estimation, thus reduces route error rate. So, time taken for data packets to reach the destination is decreases. Further, CBRRP includes residual energy and mobility parameters of the vehicles along with link lifetime for route selection, offers 14% faster in networking of data packets than En-AODV. In addition, figure 3, 7 shows the delay performance of CBRRP and is increases to 9% for different vehicle densities, 40 and 100. This is due to increase in number of vehicles and results into increases in number of connections in the network. Therefore, average time taken for data packets to reach per second increases. On the whole proposed CBRRP has superior performance over existing En-AODV for increase in density.

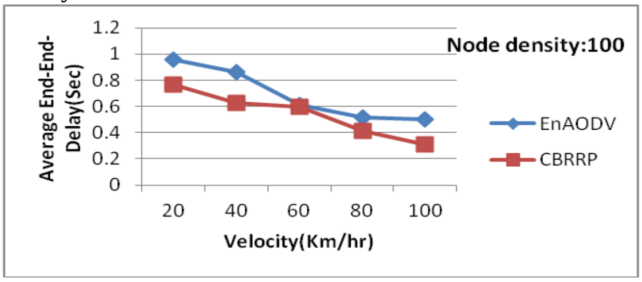

Fig.7. Impact of different velocities on packet delay.

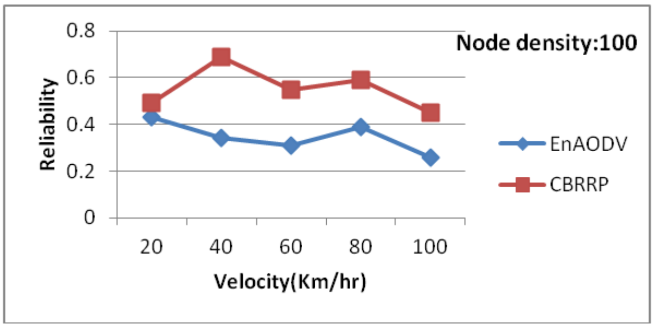

Fig.8. Impact of different velocities on Reliability

Fig.8. shows the impact of vehicle velocities on reliability performance parameter proposed CBRRP and existing En-AODV with node density equal to 100. Results illustrates that reliability gradually decreases in both CBRRP and En-AODV as mobility increases due to loss of connectivity. However, the Proposed CBRRP offers 37% higher reliability than En-AODV, as CBRRP selects stable paths by considering accumulated link reliability along with energy consumption and mobility parameters. Thus, the ratio of successfully received data packets at the receiver to that of sum of data packets received and lost is high in CBRRP. In general reliability is denoted by R and lies between 0 and 1, if R=1 shows the best case. On the whole, reliability in CBRRP is improved to 10% against increase in vehicle density from 40 to 100 in the network.

V. CONCLUSION

In this paper, a cross layer based routing scheme named CBRRP has been proposed for VANET. The performance of CBRRP is evaluated along with other cross layer reactive protocol En-AODV. From the simulation results, it is evident that CBRRP provides better results compared to En-AODV in terms of reliability, throughput, energy consumption and end to end delay. In future, the performance of proposed CBRRP will be analyzed for different QoS metrics at higher mobility and density of vehicles.

REFERENCES

1. Yao, Y., Cao, Q., & Vasilakos, A. V, "EDAL: An energy efficient, delay-aware and lifetime-balancing data collection protocol for wireless sensor networks", in Proceedings of the IEEE 10th international conference on Mobile ad-hoc and sensor systems (MASS) (pp. 182–190), 2013.
2. Zhou, L., et al, "Distributed media services in P2P-based vehicular networks", IEEE Transactions on Vehicular Technology, 60(2), 692–703, 2011.
3. Nishanth, R. B., Ramakrishnan, B., & Selvi, M, "Improved signcryption algorithm for information security in networks", International Journal of Computer Networks and Applications (IJCNA), 2(3), 151–157, 2015
4. E. Sakhaee and A. Jamalipour, "Stable clustering and communications in pseudo linear highly Mobile Ad hoc Networks," IEEE Transactions on Vehicular Technology, vol. 57, no. 6, pp. 3769–3777, 2008.
5. T. Camp, J. Boleng, and L. Wilcox, "Location information services in mobile ad hoc networks," in IEEE International Conference on Communications. Conference Proceedings. ICC 2002, vol. 5, 2002, pp. 3318–3324.
6. J. Singh, N. Bambos, B. Srinivasan, D. Clawin, Cross-layer multi-hop wireless routing for inter-vehicle communication, in Proc. 2nd International Conference on Test beds and Research Infrastructures for the Development of Networks and Communities (TRIDENTCOM), 2006, pp. 92–101.
7. C. Yufeng, et al., "A cross-layer AOMDV routing protocol for V2V communication in urban VANET," in Proc. 5th Int. Conference on Mobile Ad-hoc and Sensor Networks, 2009, pp. 353-359.
8. B. Yuanguo, et al., "Efficient and reliable broadcast in inter vehicle communication networks: a cross-layer approach," in IEEE Transactions on Vehicular Technology, vol. 59, pp. 2404-2417, 2010.
9. W.-H. Chen, A.-C. Pang, A.-C. Pang, and C.-T. F. Chiang, "Cross layer cooperative routing for vehicular networks," in Proc. IEEE ICS, Dec. 2010, pp. 67–72
10. K. Katsaros, M. Dianati, R. Tafazolli, and R. Kernchen, "CLWPR: A novel cross-layer optimized position based routing protocol for VANETs," in Proc. IEEE Vehicular Networks Conference (VNC), Nov. 2011, pp.139–146.
11. S. ur Rehman, M. A. Khan, and T. A. Zia, "A multi-hop cross layer decision based routing for VANETs," Wireless Networks, vol. 21, no. 5, pp. 1647–1660, Jul. 2014.
12. Oliveira, Renê, Carlos Montez, Azzedine Boukerche, and Michelle S. Wangham. "Reliable data dissemination protocol for VANET traffic safety applications." Ad Hoc Networks 63 (2017): 30-44.
13. M. S. Rayeni, A. Hafid, P. K. Sahu, Dynamic spatial partition density-based emergency message dissemination in VANETs, Vehicular Communications 2 (4) (2015) 208 – 222.
14. P. Salvo, M. De Felice, A. Baiocchi, F. Cuomo, and I. Rubin, "Timer Based Distributed Dissemination Protocols for VANETs and Their Interaction with MAC Layer," in Vehicular Technology Conference (VTC Spring), 2013 IEEE 77th, June 2013, pp. 1–6.
15. ur Rehman, Sabih, M. Arif Khan, Muhammad Imran, Tanveer A. Zia, and Mohsin Iftikhar. "Enhancing Quality-of-Service Conditions Using a Cross-Layer Paradigm for Ad-Hoc Vehicular Communication." IEEE Access 5 (2017): 12404-12416.
16. Shafi Shaik, D.Venkata Ratnam, B.N.Bhandari, "An Efficient Cross layer Routing Protocol for Safety Message Dissemination in VANETs with Reduced Routing Cost and Delay using IEEE 802.11P", Wireless Personal Communications,2018, Volume.100, issue 4, pp 1765-1774.
17. Shaik Shafi, B.N.Bhandari, D.Venkata ratnam, A Cross layer design for efficient multimedia message dissemination with an adaptive relay nodes selection in VANETs, in: Signal Processing and Communication Engineering Systems (SPACES), 2018, pp.81-84.
18. S shafi, D.Venkata Ratnam, B.N.Bhandari," ECBP: An Energy Efficient Cross Layer Cluster Based Routing Protocol", International Journal of Engineering & Technology, 7 (3.29) (2018) 479-482
19. B. Moussaoui, Soufiene Djahel, Mohamed Smati, John Murphy, A Cross Layer Approach for Efficient Multimedia Data Dissemination in VANETs, Vehicular Communications, volume 9, (2017), pp. 127-134.