Mobility Aware Routing in VANET

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Abstract—VANET, Vehicular Ad-hoc Network is very emerging area of research. There are lots of applications like; Message Transmission, for example – Infotainment (Information + Entertainment), Emergency Safety Messages, convenience messages, Commercial Messages etc. can be transmitted using VANET. There are many researches done on VANET bus still it has many issues. Because of high mobility of nodes in VANET, node to node data delivery is also a crucial issue as its achieved 100% due to intermittent connectivity. So our motivation is to design a protocol in which chances of data delivery increases. In our proposed work, data delivery should be Mobility Aware. That means no blind data delivery from any node to any node. Sender will estimate the speed of neighboring node and it will set a priority of message sending to the node which is having highest speed.

Key words: ANET, mobility, routing, AODV, cross-layer design.

I. INTRODUCTION

Vehicular Ad hoc Network (VANET) is an instance of Mobile Ad hoc Networks (MANET), which forms wireless networks between vehicles, which are general-purpose distributed wireless networks interconnected without the need of any centralized infrastructure.

Vehicular Ad-hoc Networks (VANET) have different characteristics compared to other Mobile Ad-hoc Networks (MANET). The dynamic nature of the vehicles which act as routers and clients are connected with unreliable radio links and Routing becomes a complex problem. Moreover, the frequent disconnection in the VANET topology makes packet delivery more difficult [1].

Objective of VANET is to provide right information to users avoid the accidents and safe the journey by enabling communication between the vehicles. VANETs are composed for a set of communicating vehicles equipped with wireless network devices that are able to interconnect each other without any pre-existing infrastructure that means ad-hoc mode.

IEEE 802.11 standard provides IEEE 802.11p is an outline for adaptation to add Wireless Access in the Vehicular Environment (WAVE). To support Intelligent Transportation System (ITS), IEEE 802.11p defines augmentation to 802.11. IEEE 802.11p comprises data transformation between high-speed vehicles and along the vehicles and the roadside units (RSUs) on ITS band of 5.9 GHz (5.85-5.925 GHz) that is licensed ITS band. IEEE 802.11p is based on IEEE 1609, which is a higher layer standard [2].

A. *VANET Structure*

1) Vehicle-to-Vehicle (V2V)
2) Vehicle-to-Infrastructure (V2I)

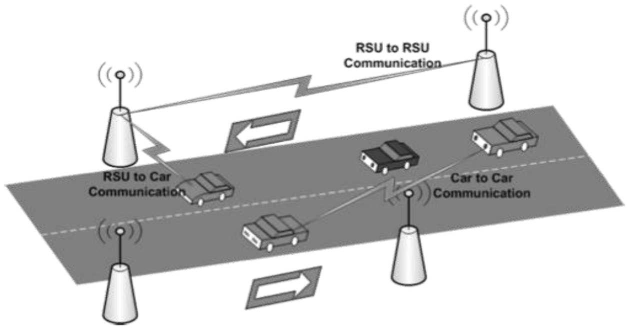

Fig. 1: VANET Structure [7]

As shown in Fig. 1, VANET comprises with two modes of communication. RSU (Road Side Units) like base stations can be a part of communication and OBU (On Board Units) like Network Interface Card or other chip that is with vehicle are useful to communicate with other vehicles.

In VANET, communication may be between two vehicles via Ad-hoc connection that is referred as Vehicle-to-Vehicle (V2V) communication and the communication between vehicles and infrastructures referred as Vehicle-to-Infrastructure (V2I).

We can also define another kind of communication in VANET that can be referred as Hybrid communication. In VANET structure, there may be a vehicle that is communicating with RSU as well with other vehicles, that kind of communication is known as Hybrid communication in VANET.

B. *VANET Applications*

There are lots of applications of VANET; we can classify them as per follow.

1) *Safety Applications*

The safety applications of VANET are Slow/Stop vehicle advisor (notifications), co-operative collision warning (useful for traffic control), post-crash notification, road hazard control notifications etc. can be considered.

2) *Convenience Applications*

The convenience related applications of VANET can be specified as congested road notifications parking availability notifications etc.

3) *Commercial Applications*

There are also some commercial applications like advertisement, service announcements etc. are the applications of the VANET.

C. *VANET Open Issues*

VANET presents unique features and such unique features present challenges at different layers of the communication protocol stack. Challenges in VANET created by Channel conditions, node density, and dynamic topology changes. Signal quality and Bit Error Rate (BER) performance are affected by speed of vehicles and communication scenarios like buildings, trees etc. High node density (due to an accident or traffic jam) degenerates the performance of the contention based non-deterministic DSRC medium access control (MAC) layer by inducing network congestion and high rate of collisions[2].

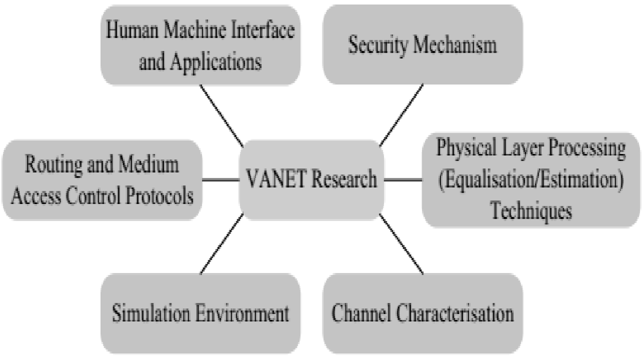

Fig. 2: VANET Open Issues [2]

Thus open issues for VANET, we can derive as frequent disconnection (due to high mobility), data delivery issues because of delay, congestion and throughput, Security (trust) related issues, other vehicles' movements and traffic rules etc.

There are many routing protocols that have been proposed and assessed to improve the efficiency of VANET. Most commonly used routing protocols for VANET, i.e. outstanding enhancements in performance and robustness shown by DSR (Dynamic Source Routing) and AODV (Ad hoc On-Demand Distance Vector). AODV (Ad hoc On Demand Distance Vector) protocol was designed. This protocol uses a routing table and performs better than DSR, but is more difficult to implement because it uses advanced features as timers and sequence numbers [3].

In AODV algorithm, each routing table entry contains destination address, next hop, and number of hops, destination sequence number, and information of active neighbors for this route and expiration time for this route table entry [9]. But it does not have any information related to the speed and distance of other nodes which are in the sender node's range.

Our proposed algorithm will find out the fastest node by sorting the RSSI (Received Signal Strength Indicator) values in routing table and hence data first of all, will be delivered to fastest node. Thus we can get maximum data delivery to the nodes.

II. RELATED WORK

After many researches, there are many protocols and algorithms provided as a solution to improve the VANET routing and make it efficient by cross layer optimization. Due to high mobility, frequent connection/disconnection is the main issue to VANET as compared to other Mobile Ad hoc.

Some research done on mobility aware routing, they suggested to use a hybrid routing approach with the ability to adapt according to the node mobility could improve the performance of MANETs. However, existing hybrid protocols (e.g. the Tooska scheme) do not consider node mobility. Therefore, their paper, proposes a Mobility Aware Hybrid Routing (MAHR) approach for MANETs, which varies its routing between a reactive and proactive approach according to the node mobility. They used OLSR (Optimized Link State Routing) - a proactive protocol and AODV (Ad-hoc On Demand Distance Vector) - a reactive routing protocol. In general, proactive routing performs well in static scenarios or in small networks, whereas reactive routing is more effective for dynamic environments or large networks. As such, a hybrid routing protocol can benefit from the advantages of both approaches, while alleviating the disadvantages, plus. The ability to adapt according to the node mobility could improve the performance of MANETs. According to the mobility conditions, some nodes update their routing table, as with a proactive protocol, while other nodes follow the AODV protocol. But in VANET scenario, mobility is very high, so no need to use any proactive protocol, and so we considered to go further with AODV (Ad hoc On Demand Distance Vector) protocol [6].

A. *AODV Algorithm*

AODV is a reactive routing protocol, which operates on hop-by-hop pattern. AODV defines three message types. Route Requests (RREQs), Route Replies (RREPs), and Route Errors (RERRs).

In AODV routing, sender nodes record the address of the nodes based upon the broadcast reply of Root Request (RREQ) to the receiver nodes. Fig. 2.a shows the nodes sending the request query. This methodology of recording its previous node is called backward learning. As shown in Fig. 2.b when Root Reply (RREP) packet arrives at the destination node, a reply packet (RREP) is then sent through the complete path that obtained from backward learning. The node would record its previous node or hop, at each stop of the path and thus the forward path from the source is inaugurated. Thus it initiates a full duplex path. After the path is initiated, it is maintained as long as the source node uses it [4].

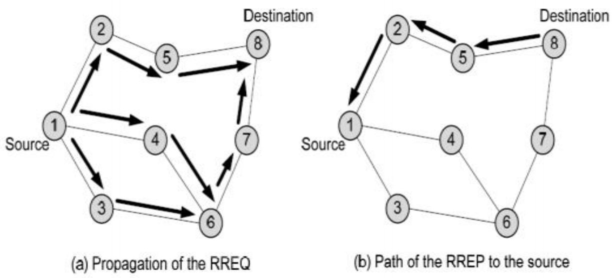

Fig. 2: AODV Route Discovery [4]

Three main tasks of AODV are, Route Discovery, Route Table Management, Route Maintenance and Route Errors (RERRs).

1) *AODV Route Discovery*

AODV uses route discovery by broadcasting RREQ to all its neighboring nodes. The broadcasted RREQ contains addresses of source and destination, their sequence numbers, broadcast ID and a counter, which counts how many times

RREQ has been generated from a specific node. When a source node broadcast a RREQ to its neighbors it acquires RREP either from its neighbors or that neighbor(s) rebroadcasts RREQ to their neighbors by increment in the hop counter [4].

2) AODV Table Management

The routing table entries of nodes which are no longer exist in the route between source and destination; need to be avoided by AODV Table Management. In AODV Managing routing table information handled with the destination sequence numbers [4].

3) AODV Route Maintenance

When nodes in the network detects that a route is not valid anymore for communication it delete all the related entries from the routing table for those invalid routes. And sends the RREP to current active neighboring nodes that route is not valid anymore for communication. AODV maintains only the loop free routes [4].

B. Cross Layer Optimization of AODV

Research shows that modified version of AODV routing protocol, based on route discovery by utilizing Physical Layer information instead of the minimum hop count approach of the default distance vector algorithm. The research also elaborates how the proposed model uses the received SNR (Signal to Noise Ratio) to find its route. Their results of the simulations show improvement on the existing default AODV performance metrics like MANET traffic throughput, application specific response time, data dropped, delay etc. [5].

The concept of cross-layer design is based on architecture where the layers can exchange information in order to improve the overall network performances. In MANET MAC for 802.11b uses CSMA/CA for accessing the channels by different nodes. But, one of the major concerns is not only selecting the nodes along with the path from source to destination but also pick those nodes in such a way that, they provide best service in the form of relaying data with high rate, least error and least time [5].

The reactive routing protocol reduces the overhead traffic by creating a route only when it is required. In AODV, each routing table entry contains destination ID, next hop, and number of hops, destination sequence number, and information of active neighbors for this route and expiration time for this route table entry. In proposed SNR based AODV model assumes that, during the route discovery process, each node has the channel side information available in terms of received SNR in that packet transmission. While a node receives the route request, it also has the information of the SNR. If the node takes part in the route reply process, then it stores the SNR value in the buffer. During the reverse path setup of routes, the SNR values along [5].

III. PROBLEM UNREVEALED

There are many researches done to come over the main issue of VANET like frequent disconnection due to high mobility. By use of SNR, we can get data delivery with high rate, least error and least time. But, we can't get 100% data delivery ratio. So we provide some Mobility Aware Cross Layer Design, and proposed an algorithm that uses an RSSI (Received Signal Strength Indicator) value. This proposed solution will enhance with AODV algorithm to increase the data delivery ratio.

IV. PROPOSED ALGORITHM

Below is the algorithm that we have proposed.

Sender Side:
Sender ()
FindFastest ()
    Send B_Cast Hello-Packet () // Node sends the broadcast packet to the neighbors
    Store RSSI value in DB // Node stores the RSSI (Received Signal Strength Indicator) value to the buffer
    Calculate Fastest_neighbor ()
    Set Destination_ID = Fastest neighbor ()
    Send (packet)

Receiver Side:
  Check for Destination_ID
  If Destination_ID matched
    Receive (packet)
  Else
    Call forward // Using FindFastest ()

Here, as per AODV Algorithm, Sender will broadcast the 'Hello Packet' to all the neighboring nodes. And all the neighboring nodes will reply Response Packet (RREP) with their RSSI value. Sender will store the RSSI (Received Signal Strength Indicator) values of all the nodes to buffer.

From RSSI values of all the nodes, Sender will then calculate the neighboring node with the lowest RSSI value, as its obvious thing that node which is having lowest RSSI value may be either very fast or very far from the sender node and it may go away from sender node's range in a very short time.

Thus, by calculating the fastest node, Message will be sent with the destination ID as a fastest node's ID (or we can say, destination ID of the node which is having lowest RSSI value), and the same process will continue to send message to all the neighboring nodes. And thus we can get maximum data delivery to the neighboring nodes.

And the receiver side, initially, it's the same process as per the AODV algorithm. Receiver will check the destination ID and if it get its own ID, then it'll accept the message otherwise it will forward the packet by finding the fastest neighbor.

V. CONCLUSION

As Vehicular Ad hoc Network (VANET) is very emerging research area, there are many issues need to be researched on. Here we have studied the main issue of VANET that is frequently disconnection due to very high movement of nodes. And due to high mobility, there are many issues like; delay in data delivery, signal quality, Bit Error Rate, throughput and performance etc. Our proposed algorithm is a possible way to increase the data delivery among the nodes in Vehicular Ad hoc Network (VANET) and to get maximum data delivery.

REFERENCES

[1] Prasad N. Perera and Dhammika Jayalath “Cross Layer Optimization of VANET Routing with Multi-Objective Decision Making” IEEE, 2012.
[2] Harsh Trivedi, Prakash Veeraraghavan, Seng Loke, Aniruddha Desai and Jack Singh “SmartVANET: The Case for a Cross-Layer Vehicular Network Architecture” Workshops of International Conference, 2011.
[3] L. Mucchi, L.Chisci, G. Giovannetti and L. Fabbrini “Robust Cross-Layer Routing Protocol for Mobile Ad Hoc Networks” IEEE, 2012.
[4] Tajinder Kaur and A. K. Verma “Simulation and Analysis of AODV routing protocol in VANETs” IJSCE, 2012.
[5] Muhammed Kamrul Islam and Rong Ke Liu “Cross-Layer Optimization of AODV Routing Protocol For Mobile Ad-Hoc Network (MANET)” ICCSEE, 2013.
[6] Mi-Seon Kang, Dong-Won Kum, Jae-Seung Bae, You-Ze Cho and Anh-Ngoc Le “Mobility Aware Hybrid Routing Protocol for Mobile Ad hoc Network” IEEE, 2012.
[7] Ghassan Samara, Wafaa A.H.Al-Salihy and R. Sures “Security Analysis of Vehicular Ad Hoc Networks” 2010 Second International Conference on Network Applications, Protocols and Services.

