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Reliability Techniques for Data Dissemination in VANET : A Short Survey

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ABSTRACT

VANET (Vehicular Ad-Hoc Network) is one type of mobile network which includes features like node mobility and frequent topology changes because of which it has become an emerging research field. It works as a carrier of information for its users. VANET enables Safety applications like cooperative driving and accident avoidance and Non-Safety or user applications providing value-added services like toll service, Internet access, cooperative entertainment etc. Which brings challenges for the developers and Communication Engineers. As it is having frequent topology changes, data dissemination with the reliability of data is an important aspect to be considered. In this paper, we focus on different reliability techniques basically which are using network coding for reliable data dissemination issues.

Keywords: Reliability Techniques, Network Coding, Vehicular Ad-Hoc Network, Data Dissemination

I. INTRODUCTION

VANETs (Vehicular Ad-Hoc Networks) are kinds of MANETs (Mobile Ad-Hoc Networks) in which infrastructure and traffic rules restrict the node's mobility [1]. VANETs are the most emerging research field in terms of network technology, communication technology as well as for automobile industry. The vehicles communicating in VANETs are known as nodes. The main concern in any communication is the reliability of data, and because of the continuous movement of nodes in VANET reliability of data becomes more important. Nodes use different techniques, routing protocols, applications and its combinations of communication according to its requirements in different scenarios. VANET is also known as a frequently disconnected network because of the vehicle movement because of which it requires authentic and quick data dissemination. For data dissemination in VANET techniques like SSDNC[2], NCMPTCP[3], DTN[4], EGwR on 1-D to the 2-D environment[5], interflow network coding[6], cross-layer approach[7] and much more are available and still research is going on. These techniques are applied in different scenarios and different simulations are used for an experimental study. With many issues in most of the techniques, data reliability is considered as the common issue faced by the researchers. This paper focuses on different techniques available and issues with it.

II. ARCHITECTURE OF VANET

Figure 1 represents the general VANET Architecture showing the Vehicle-to-Vehicle communication, Vehicle-to-Roadside communication and Infrastructure-to-Infrastructure communication.

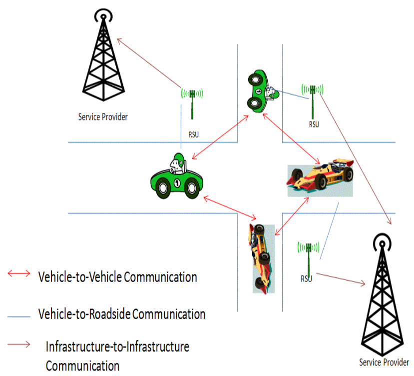

Figure 1. General VANET Architecture

The rest of the paper is organized as follows: Section III describes related work while section IV discusses various research challenges and finally we concluded with some future direction in section V.

III. RELATED WORK

Travel has been and continues to be an important part of most human's daily lives, because of which vehicles like the car have become the most popular mode of transport. While the use of information technology in vehicles is advancing, the importance of vehicles information security is also increasing in Vehicular Ad-hoc networks. Because of a fast speed of the nodes, it is important to increase throughput, the stability of data and decrease the average delay to have better data dissemination in multi-path transmission in VANET.

To get quick data transmission an MPTCP (Multi-Path TCP) was proposed for multi-path transmission by which throughput, security, and stability are increased and parallel data transmission in multiple paths gets possible[3]. Bai et al[3] proposed a new NCMPTCP(Network Codes-based Multi-Path Transmission Control Protocol providing effective and authentic transmission in VANET and with it a redundancy control algorithm which first sets the value of redundancy R and then adjusts it automatically is proposed and a Multi-path Scheduling algorithm based on RLNC for making the transmission more effective and lower the delay is proposed. NCMPTCP architecture contains encoding, scheduling, decoding, congestion control and feedback modules. The original packets are getting encoded by the encoding module and based on the estimated delivery time the encoded modules are shipped by scheduling module, while it is decoded by decoding module and feedback module ponders the loss of packet during the transmission and data sending rate is controlled by the congestion control module. The performance is evaluated considering two cases- packet loss rate and fixed delay and is compared with MPTCP and authors claims based on the results that the data transmission can be made quicker in VANET.

In 2015 Wang et al.[2] proposed a new SSDNC protocol (Source Selection Dynamically Network Coding-based Information Centric Network Protocol) which hides the difference of different sources based on the RLNC. To replace the contents which are independent of location, application and mode of information authors introduced Information-Centric Networking (ICN) in which the information becomes the first necessity and to extenuate the data redundancy caused by omnipresent cache RLNC is adopted. Scheduling Control and Decoding are two main function module of the receiver in SSDNC. The packets are received by the Scheduling Control module and global control parameter is abstracted and by a Scheduling algorithm, the number of encoded packets is scheduled for a quality source. The received encoded packets will be retrieved to the corresponding chunk in the decoding module. The approach proposed is targeting to add the additional information on whether it is having the following chinks of the content when source response an interest. To decide forwarding of the interest between interfaces in FIB entry AHP (Analytic Hierarchy Process) is used and for the purpose of valuation of SSDNC ndnSIM is used. With the proposed protocol better performance is attained in throughput and average delay.

To maintain stability and control performance rigorous end-to-end delay between source and destination is necessary for VANET. To force an end-to-end delay in VANET techniques like [4] and [5] are proposed. To supervise Vehicular Delay Tolerant Networks (VDTN) Salvador et al. [4] proposed a hierarchal architecture that often referred as management by the delegation which cut downs the delivery delay and increments the probability of delivery of notification to its destination in connected groups of vehicles. Because of the frequent link breaks a notification message might be received many times by a manager or it may not be received at all which leads to the possibility of inappropriate decisions. The hierarchical organization is composed of a top-level manager(TLM), a group of mid-level managers(MLM) and agents that are supervised by either type of managers. DTN management employs the Publisher/Subscriber model, in which the Subscriber informs about the data it wants to receive and the Publisher generates data to send to the subscriber node. To receive an arbitrary number of responses one subscription is required hence this operation reduces the overhead. The Group Detection Procedure is executed periodically by the monitored nodes, and whenever a local group is made or the MLM leaves its group the MLM election procedure is executed. ONE Simulator(Opportunistic Network Environment) is used for the evaluation and simulations. Node Setup and Simulation Setup are applied and real mobility traces and a synthetic mobility model, these two types of vehicle mobility were evaluated. Simulation results show that the hierarchy lets effectual monitoring of a node's group for near real-time applications and for non real-time applications because of aggregation process in the MLM it cut downs the number of messages in the network which ultimately cut downs the delivery time.

The use of smart phones has made the vehicles a carrier of mobile phones which has aroused many new applications which increases the requirements on data dissemination. The communication takes place by the use of the road network which is more complex than highways in urban areas, it may have a shorter distance between intersections with maybe 3-way, 4-way and even more, which may have irregular roads of Y-shape and U-turn. Considering all these possibilities Zhao et al.[5] proposed an EGwR (Evolving Graph model with Reliability) based link reliability model for urban VANETs. Link duration time is one of the most important factors for determining the reliability of data dissemination and in EGwR depiction of the link reliability is done by the link duration time distribution. Authors have derived link reliability with the use of a number of equations. Route selection of the packets can be done using EGwR. At a certain time interval, the value of changes in the movement direction and speed of nodes can be calculated in advance if we know its value, which successively is used for forecasting the link reliability and the route for packet delivery. Network Simulator NS2 is used to conduct an experimental study by performing ten runs to obtain its average results, The results of the simulation are compared between directly selecting the best neighbor, globally computing an optimal route and the flooding based on the public transport facilities. The performance comparison is made between data delivery ratio, the node forwards proportion and data delivery delay which shows a direct selection of the best neighbor globally computing optimal route can cut down transmission delay and favorably save bandwidth at the guaranteed delivery ratio.

Dynamic network topology of VANET makes the multi-hop communication challenging in VANET. MAC Layer (Media Access Control) which is providing flow control and multiplexing for the physical link can be considered to make the multi-hop communication simpler in VANET. For providing effective data dissemination Wu et al.[6] proposed a BBNC, a BackBone based routing protocol with inter-flow Network Coding, which chooses backbone nodes and sends on packets using the chosen backbone nodes reducing the MAC layer contention time and the number of transmitted packets is reduced by 25% because of inter-flow network coding which ameliorates the MAC layer contention efficiency and may gain lower end-to-end delay, lower overhead and higher reliability as equating with the formal approach. Hello messages are used to send information of velocity of vehicles and the number of neighbor vehicles driving to the same direction by each node calculating a compentency value for each hello interval for itself and each neighbor vehicle. If the compentency value is large in node's neighborhood then using the next hello message the node announces itself as a backbone node, which cut downs MAC layer contention time and increases the chance of using inter-flow network coding at the intermediate nodes. The fuzzy logic based algorithm is used to calculate the competency value for a neighbor node, which includes multiple factors based on which fuzzification and mapping and a combination of IF/THEN rules are applied and the fuzzy results are defuzzified using the COG (Center of Gravity) method of defuzzing. Each road is having a unique road ID that is known by each node and the selection of backbone is done on a road basis. Vehicles are having a memory device of data storage size of 16,384 KB because of which the performance of the protocol is not getting spoiled. The proposed protocol is simulated using ns-2.34, TIGER line map file, a real street map model and for channel fading the Nakagami propagation model considering different parametric quantities like Backbone Vehicle Change Rate, Packet Delivery Ratio, Number of Transmissions per successfully Delivered Packet, Normalized Protocol overhead and End-to-End Delay which proves that it reduces the number of data transmission required which ultimately decreases the end-to-end delay. Table-1 shows the end-to-end delay comparison of formal approach and proposed BBNC approach.

Table 1. End-to-end Delay Comparison

No. of Traffic Flows	Contention Delay (slot time)		Propagation Delay (Propagation Time)	
	Formal Approach	Proposed BBNC	Formal Approach	Proposed BBNC
2	100	40	4	3
3	400	100	6	4
4	620	190	8	6
5	1000	390	10	7
6	1300	600	12	9
7	1580	800	14	10
8	1800	1100	16	12

Recent research in VANET for message broadcasting is forcing the end-to-end delay and data reliability which requires the selection of uttermost relay from source and to maintain connectivity of link and performance improvement it is essential to have cross-layer coupling between physical layer, MAC layer and network layer[7]. In 2017 Gawas et al. [7] proposed a cross-layer based distributed co-operative safety messages broadcast algorithm by using cross-layer coupling of the network, MAC and physical layer. The REQB control packet containing the address of source node, message, direction, position, velocity and sequence number is propagated by the node and the time $Timer_{REQB}$ is started. The relay node is selected based on the values of W_{relay}, $W_{relaymax}$, and $W_{relaymin}$. After Performing qualifying test each node sends REPB if qualified and if not qualified, sets their NAV and defer their transmission accordingly. A node with minimum W_{relay} gets the channel access and the source node propagates the message to the selected relay. The relay sends ACK on successful reception of the message. The proposed scheme is evaluated and compared with VDF and IEEE 802.11p results in a reduction in redundant messages and fast delivery.

To get the best possible performance in VANET it is important to ensure bandwidth utilization in both safety and non-safety applications in VANET which ultimately helps in achieving quick response time and reducing deadline miss ratio. **Vehicle-to-Infrastructure(V2I)** communication which uses RSUs as a buffer point along roadside is used to come out the problem of short connecting time of vehicle-to-vehicle. Vehicles will be failed to receive their required data items on time if effective data dissemination between RSU and Vehicle is not established[8]. According to Ali et al. [8], they have proposed the first approach which applies network coding with on-demand broadcast in VANETs, with the objective of reduction in the deadline miss ratio and the response time. The proposed network coding-based request serving approach starts its work by updating the cache information of RSU about vehicle Vh_i. The requests are added and requested data items popularity is updated. The serving feasibility check on each pending request is applied, and infeasible requests are discarded. CR-graph G(V, E) is constructed. According to the underlying scheduling algorithm, a data item is selected and to cover it a maximum clique α_{max} is found in which data items are encoded and ResCH broadcasts it. V(G) gets updated and the satisfied request from the service queue is removed, for all the vehicles received and broadcast data item the cache information of RSU is updated. If the vehicle Vh_i continues to generate a request, the steps from adding request to update cache are repeated, and if the vehicle exits the range of current RSU and moves to another RSU the updates cache information of the vehicle is transferred to the next RSU. To simulate multiple RSU Ali et al. integrated on-demand scheduling algorithms with the proposed network coding based request serving approach and for analysis of the performance of all different algorithms are used in compared of without coding which shows that the system with network coding disseminate more than one different data item per broadcast while the system without coding disseminates only one data item limiting the broadcast bandwidth usage.

VANETs are also having applications providing value-added services like entertainment applications[9]. Entertainment applications include point-of-interest notification applications, automatic- access control/parking access applications and local electronic commercial applications having relaxed time constraint which are more bandwidth consuming[10]. When a packet is received in VANET relay may face the problem of whether to wait for a coding opportunity and saving the bandwidth utilization or to send the packet directly for reducing the delay. Ahmed et al. [10] have proposed two versions of protocols having the names as BSCS(Buffer Size Control Scheme) and TCS(Time Control Scheme) to overcome the problem relay facing in VANET. Authors have proposed these two schemes with the objective of better bandwidth utilization and keeping network congestion down in the multimedia data dissemination scenario. To reduce the bandwidth consumption the proposed scheme is using network coding to encode the packets received from different sources before rebroadcasting the packet in the network. It is assumed that the relay performs a bitwise XOR operation on the received packets before broadcasting them and is able to forward the packets having knowledge of average data rates of sources. The relay maintains a queuing buffer. The BSCS(Buffer Size Control Scheme) as the name suggests is aiming to control the imposed delay by controlling the size of the buffer. The TCS (Time Control Scheme) works upon setting a delay limit for each packet, which means the packet will not be buffered more than a certain time T_{max}. The performance evaluation in stationary and mobile relay scenarios includes many parameters which reveal that up to 38% improvement is recorded in the bandwidth utilization.

The implementation of VANET applications is done inside of a certain simulator so need to adapt the source of the application to shift the simulator. As an effort of making VANET components accessible in a unified way Ebers et al.[1] developed VaSili(VANET Simulation Runtime) to make VANET components accessible in a unified way. VaSili is composed of three modules: A Network Simulator, A Traffic Simulator and Java VANET Simulation Environment(JASmin). Each module contains a System Clock which is independent of real-time but dependent on the progress speed of the simulation. JASmin and NS may run in the same processor in the different processes for the purpose of communication. While shifting from one simulator to another all parts remain unchanged the only part getting altered is the adapter component which can be of two types Socket-based or JNI based. For the Shawn VANET simulator, a first JNI-based adapter is made by implementing the proposed VaSili specification and JASmin. The evaluation result shows that when not transmitting a message the average overhead imposed by VaSili is 8% and not more than 12% when transmitting messages.

IV. RESEARCH CHALLENGES AND ISSUES

Vehicles are becoming a part of the global network because of the advances in the wireless technology, and the network used for data dissemination in Vehicles is called as Vehicular Ad-hoc Network(VANET). [9] and [11] has focused many live research issues in VANET for reliable data dissemination which are as follow :

Mobility Model and Routing Protocols: VANETs is a kind of wireless ad-hoc network which includes frequent topology change. As the Vehicles within their communication range will be in touch for few seconds, ample topology model providing significant interaction between receiver and sender can be developed, as well as ample routing algorithms providing high throughput and improved packet-delivery ratio can also be developed[9]. According to [11] for properly utilizing the available bandwidth and available energy resources for achieving high throughput and high packet delivery ratio new routing protocol can be suggested.

Scalability Protocols: Because of varying traffic density in different areas, the design of scalable protocol and number of active Vehicles on that communication range is also an issue in VANET[9].

Security: Kabir in[9] says, as VANETs are communicating using wireless network there are chances of getting damages in information by fraud node which may reduce the overall performance of the network so security solutions involving minimum such fraud nodes can be provided.

Architecture: In future VANETs may run on different technology combinations like Wifi, radio spectrum 5.0, UMTS, IEEE 802p DSRC, ZigBee, Bluetooth, IRA, WAVE, ITS G5 or 3G/4G and heterogeneous vehicular networks, so it is advisable to consider its architecture aspect, which should be flexible and reliable enough to accommodate different technology combinations.

***QoS(Quality of Service) and Broadcasting*:** In [9] Kabir has also prompted, issue of utilization of allocated bandwidth for improved message delivery and development of QoS routing protocols for effective and fast establishment of new routes with reliable data dissemination using effective and co-operative broadcasting algorithms. Dixit In [11] mentioned that VANETs are having frequent topology changes and disconnections because of the high speed of vehicles which makes quality maintenance very difficult in VANET and to maintain quality a solution can be provided using available resources. While broadcasting the message challenges like a collision in the message, hidden node problems aroused and as broadcasting protocols will be broadcasting the messages to its users it is important to have fast, reliable and robust broadcasting protocol[11].

Standards: As a number of vehicles increasing day by day, current MAC parameters of IEEE 802.11p protocol configuration is not efficient which leads to the requirement of improvement in standards[11].

High-Speed Wireless Communication Technology: To provide the air interface protocols high-speed wireless communication technologies can be proposed supporting fast, high speed of vehicles in VANET[11].

Connectivity: It's a great challenge to connect vehicles for maintaining communications with constraints like a fast speed of vehicles, network topology changes, channel bandwidth, infrastructure, geographic constraints etc.[11].

The literature reviewed in this paper also introduced issues which are also discussed here. In VaSili[1] authors have considered a simple scenario of communication range of 250 meters, 616 vehicles in a 10km round course and one message transmission per second, hence with the execution of more complex algorithm, the overall execution time may get increased. While developing SSDNC the disorder issue appeared which was solved by the use of Network Coding[2] and more improvements are suggested to make it more desirable for VANETs. Salvador et al. [4] says the hierarchical architecture is yet to taste with the remote communication in VDTNs, and more refined algorithms for the election of leaders and group detection can be proposed. In [6] Wu et al. have considered many different scenarios like freeway scenarios, street scenarios and city scenarios for the result evaluation and it can further be extended to a scenario with a network having large network diameter.

V. CONCLUSION

The paper provides an overview of different data dissemination techniques in both safety and non-safety applications in VANET. The techniques reviewed in this paper uses network coding to improve throughput and make data dissemination reliable on VANET which also arouse many issues most of which are focused in this paper. VANET is emerging research field having many challenges which are unfocused and still a lot of work remains to be done.

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