



Multicasting Data Routing for Vehicular Ad hoc Network using Fog Computing

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Abstract

A group of vehicles either mobile or stationary that is interconnected through a wireless network generate a vehicular ad hoc network (VANET). Providing comfort as well as safety to the drivers in vehicular scenarios is the main importance of VANETs. Since there is an increase in the number of autonomous vehicles, these networks are now being considered as an infrastructure for an intelligent transportation system. Fog computing can be provided low latent information sharing and more background knowledge by localizing one of the features. This research work is related to data aggregation in vehicular ad hoc networks. In this research work, the technique of multicasting will be proposed for the data aggregation in VANETs. The Network Simulator 2 is used to perform experiments and few performance measures are used for analysing the outcomes..

Keywords: VANET; Fog Computing; Data Aggregation; Multicasting

1. Introduction

A group of vehicles either mobile or stationary that is interconnected through a wireless network generates a vehicular ad hoc network (VANET). Providing comfort as well as safety to the drivers in the vehicular scenarios is the major importance of VANETs. Since, there is an increase in number of autonomous vehicles, these networks are now being considered as an infrastructure for an intelligent transportation system [1,2,3]. In a smart city, any activity requiring Internet connectivity involves VANETs. The potential of this network to provide processing and wireless communication opens many opportunities for robust applications. These applications include vehicle and road safety, traffic competence, vehicular traffic optimization, entertainment and intelligent transportation systems (ITS). The security and ease for drivers is provided by sharing data among vehicles in VANETs. In Vehicular Ad-hoc networks, wireless communication being an important technology helps to get multiple applications and services. However, the routing algorithms of MANETs cannot be used for various VANETs' applications because of different features of VANETs. These features include high dynamic topology and irregular connectedness. Over the years, a lot of efforts have been made by the researchers to improve the existing algorithms and designing the new algorithms to ensure communication trustworthiness [4,5,6]. There are mainly three categories in which routing algorithms can be divided. These categories are geo-cast/broadcast, multicast, and unicast algorithms. A brief description of these approaches is provided below:

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- **Geocast/ Broadcast algorithms:** In VANET, the geo-cast or broadcast protocols are essential to distribute messages in unidentified or vague locations. Some existing message broadcast protocols in VANETs are spatially aware packet routing algorithm, SADV and FROV. SADV approach selects optimum path for packet forwarding. FROV protocol chooses the retransmission period for rebroadcasting a message to a node [7,8,9].
- **Multicast:** Multicast routing protocols are required to establish communication amid vehicles' set in some vehicular conditions. These conditions include intersections, barricades, high traffic density, mishaps and risky road surface scenarios etc. There are mainly two categories in which multicast protocols can be divided [10,11,12].
- **Unicast:** This approach includes mainly three types of algorithms. These are greedy algorithms, opportunistic algorithms and trajectory-based algorithms. In the first type, nodes send packets to their furthest neighbours towards the destination. In second type, nodes use carry-toward method for sending the data to the destination in opportunistic manner such as topology-assist geo-opportunistic routing. In third type, nodes compute feasible routes towards the destination. The nodes send data via nodes using one or more routes. The example includes TBD (trajectory-based data forwarding) [13,14,15].

Providing services that have immensely dispersed deployments is possible using a virtualized approach named as fog computing. It provides different kinds of networking and storage services and the network interface is provided which also helps in expanding the cloud systems. Fog computing can provide a low latent information sharing and more background knowledge by localizing one of the features. Fog computing as a novel paradigm is a good aspirant for VANETs. Fog computing in MANET meets different demands. These demands include a speedy response to essential device, reduction of cloud load, analysis of real-time data stream with cloud and so on [16,17]. Fog nodes nearest to the network interface use the data provided from different devices in vehicular ad hoc network. Later, developers make decision about using them. It is a difficult task to oppose the temptation for selecting solutions on the basis of fog computing in contrast to vehicular cloud computing. Fog computing gives better results in real-time response problems.

VFC or Vehicular Fog Computing employs vehicles as the infrastructures. The main aim here is to ensure the optimal usage of computing resources and the vehicle to vehicle communication [18, 19]. In particular, Vehicular fog computing is a framework that makes use of huge number of end-user clients or near-user edge devices in collaborative manner for conducting multitude computation and communication. Unlike cloud features (e.g. providing data, computing, storage and application services to end-users), Vehicular Fog Computing (VFC) differentiates itself from other state-of-the-art approaches in terms of different features. These features include its closeness to end-users, dense environmental allocation and support for motion. In this way, VFC makes use of optimal characteristics of parked vehicles and the slowly going vehicles. Some of these features include clustering distribution in locations, to facilitate them in order to co-operate with nearby traffic flows. VFC architecture includes all vehicles which are deployed with embedded computers, gathered around the intersections of a city. In such architecture, it is also possible to deploy RSUs (road-side units) to establish connection with the distant clouds [20].

sharing in VANETs deployed in the similar county, city or state. A real time application-based prototype of protocol was also planned to be implement for evaluating its real time utility in extensive manner.

Hasan Ali Khattak, et.al (2019) recommended a VANET design based on fog-computing. An infotainment application state was also suggested in this approach [25]. In the fog-enabled VANET system, the nodes' cache size was utilized as a metric for evaluating its effect on various other performance metrics during tests. A conclusion had been made regarding this work by providing different advantages of a fog-enabled VANET. In this work, the challenges faced in future and their promising answers were investigated as well.

Joseph Khoury, et.al (2019) studied and analyzed the use of SDWN a protocol which was designed for the applications including fog computing [26]. In this work, the suspected high delay between the SDWN controller located on the cloud and its switches, the high traffic approaching to the controller, the high vehicle speed, and the range of RSU coverage were considered here. For designing a new fog computing scenario, the approach called Mininet-Wifi was applied in this research. The experiments were conducted once the novel approach was proposed to evaluate its outcomes. The evaluations showed that even though it provided certain advantages, it was not a good choice for certain kinds of scenarios.

Xiaomei Zhang, et.al (2019) incorporated the process of detecting the fault tolerance to study the issue of trust-based multi-service delivery [27]. Contemporary fog computing could provide support in the analysis and storing of relevant data in VANETs for modelling the impacts of time-varying misbehaviours. This approach also evaluated the quality parameters based dynamic trust weights of all vehicles. Afterward, these weights were included into the service delivery architecture. This architecture integrated reliable vehicle selection for misbehaviour detection. This architecture also utilized differential resource distribution for achieving misbehaviour tolerance. A multi-path selection concept based on trust assessment was recommended in this work. Moreover, another algorithm had been designed in this work over numerous routing paths. At last, wide-ranging simulations were carried out for the evaluation of recommended approach. The simulation results depicted that the proposed routing protocol showed higher successful service delivery of about 12% to 40% at the cost of satisfactory delay loss than other three routing algorithms.

Ke Xiao, et.al (2019) proposed a new mechanism through which the efficient information services could be provided [28]. An integration of the SDN and fog computing models was proposed here. Further, it aimed to formularize a new issue to evaluate the proposed method. This research aimed to coordinate the services in both cloud as well as fog layer such that the bandwidth efficiency could be maximized. An on-line scheduling algorithm had been recommended in this work. The integration of this algorithm was done with network coding. This algorithm carried out scheduling decision making at SDN controller. At last, two simulation tools called NS3 simulator and SUMO were implemented to construct a simulation model. Extensive simulation results demonstrated the dominance of the recommended system design and the answer.

3. Research Methodology

In Vanets, there is no central authority, the vehicular ad hoc network allows vehicles to join or leave the network whenever they please. Routing is a critical difficulty in automotive ad hoc networks due to the dynamic nature of the network. The most effective method for path establishment is location addict routing. The entire network will be partitioned into fixed-size zones for this study. The heads of each zone are chosen by their peers. The zones will be chosen based on the vehicles' speed and range. The zonal head will be chosen from the vehicles with the lowest speed and the most nodes in the range. For data uploading, the zonal heads will be connected to the fog server.

Following are the various phases of the proposed methodology to implement multicasting in vehicular ad hoc network.

1. The vehicular ad hoc network is deployed with the finite number of vehicles and road side units. In the network, various type of communication like vehicle to vehicle and vehicle to road side unit is possible.
2. The technique of location-based clustering is applied to divide network into fixed number of zones. The vehicles which are in the direct contact to each other are defined into the zones.
3. The vehicle node which has maximum number of nodes in their range is selected as the zonal head node. Each node in the network which presents its number of nodes in their range with the other nodes defined in the third phase.
4. The message is transmitted by the source node to its zonal head and verifies that whether it is in its zone or not. When the requesting node is in its zone, the path will be directly established from source to the destination and when the requesting node is not in its zone, the zonal head passes the request to the next zonal head. The process is repeated unless the desired path is established.

Zonal Head Selection for Multicasting Algorithm

1. Initialization
2. V= Network, S=Source, D=Destination, n=node id
3. While not end until path range and location updated do:

```

{
    3.1 Calculate Range=
    3.2 Calculate
    3.3 Location=
    3.4 If Location similar and range high accepted
        Define Zone Z
    3.5 Else
        {
            Declare new Zone Z1
        }
}

```

4. While not established between S and D

```

{
    4.1 Store Route Request (ni, Zi)
}

```

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4.2 Forward Route Request (Z_i, Z_{i+1})

4.3 While source receive route reply

```

{
    Store route reply ( $Z_i, n_i$ )
}

```

5. S transmit data to D from established path

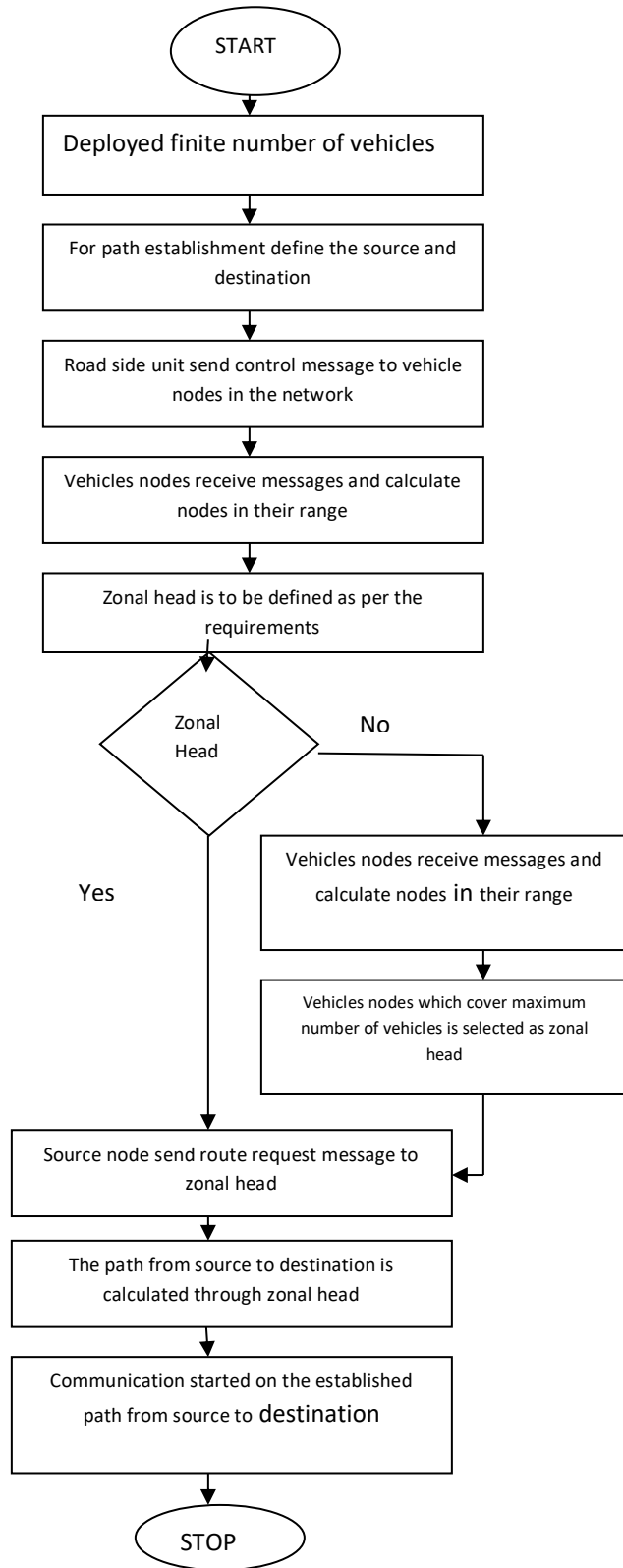


Figure 2. Proposed Methodology

4.Result and Discussion

A Vehicular Ad Hoc Network or VANET can be described as a network in which the installed vehicular devices change their locations regularly. In this work, the deployment of these devices is carried out in a particular area for the simulation of the presented model. This work makes use of a simulation tool NS2 for implementing the presented model in terms of certain metrics. The list of all these metrics is given in the table 1:

Table 1: Parameters

Number of Nodes	41
Antenna Type	Omi-Directional
Queue Type	Priority Queue
Standrad	802.11
Packet Size	1000 bytes
Queue Size	50

Table 2: NRL Analysis

Time	Existing Technique	Proposed Technique
4 second	120	90
6 second	120	80
8 second	128	70

Table 2 defines the basic parameters that are included in the simulation of proposed technique. The standards used in the simulator environment are highlighted here.

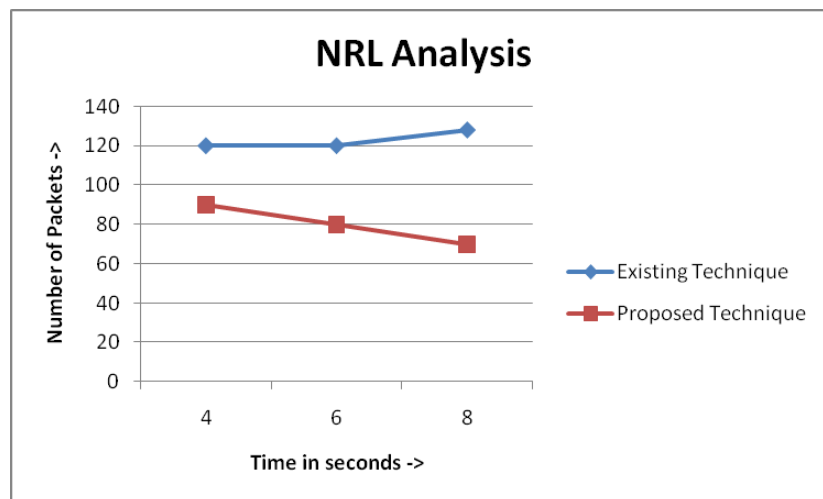


Figure 3. NRL Comparison

Figure 3 compares the earlier and the proposed approach in terms of NRL value. The achieved outcome reveals that the presented approach gets higher value of NRL than the earlier approach.

Table 3: PDR Analysis

Time	Existing Technique	Proposed Technique
4 second	0.38	0.45
6 second	0.39	0.42
8 second	0.40	0.55

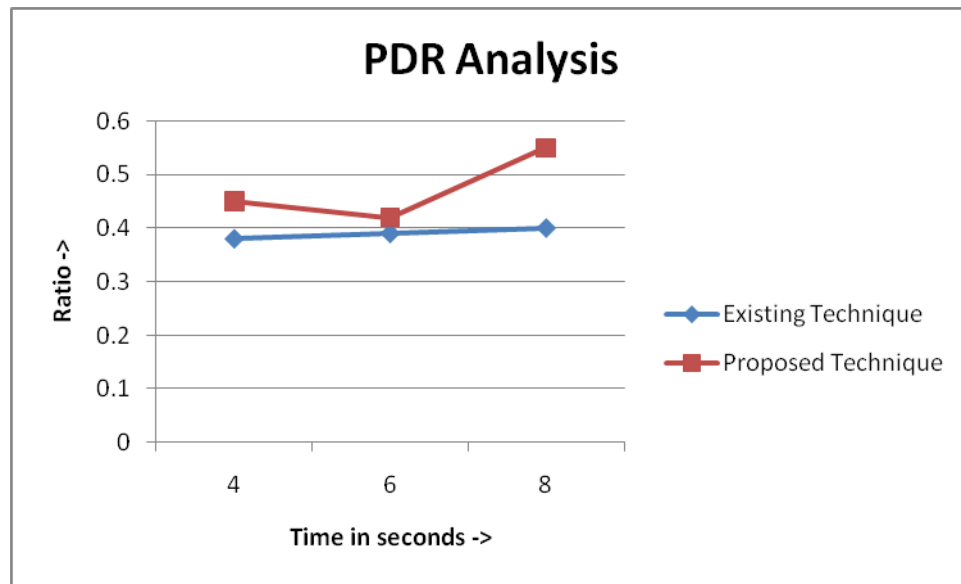


Figure 4. PDR comparison

Figure 4 demonstrates that the earlier and the proposed approaches are compared in terms of PDR (Packet Delivery Ratio). The results show that the presented approach gets higher value of PDR than the earlier approach. This increases the network throughput.

Table 4: Route Lifetime

Time	Existing Technique	Proposed Technique
4 second	73	76
6 second	75	80
8 second	79	110

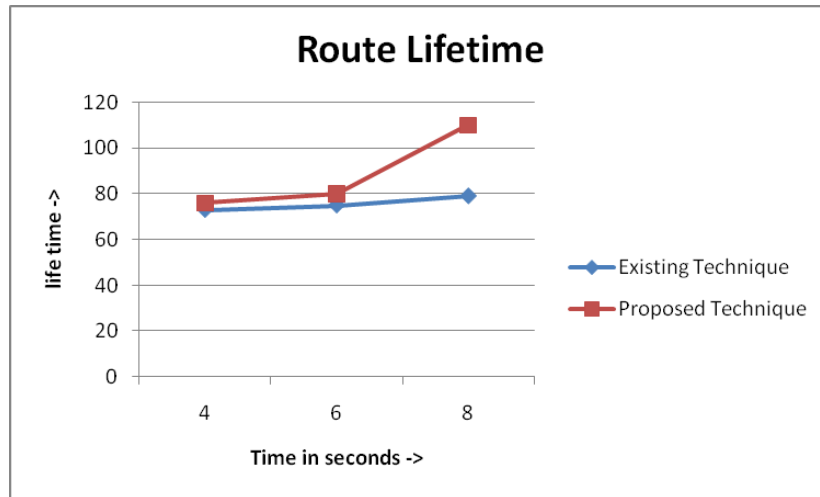


Figure 5. Route lifetime

Figure 5 demonstrates the comparison of the presented and the existing approaches in terms of the routing lifetime of the network. The output shows the increment in the life time of network because of the improvements made in this work by the implementation of the presented scheme.

Table 5: Throughput Lifetime

Time	Existing Technique	Proposed Technique
4 second	135	138
6 second	139	142
8 second	140	155

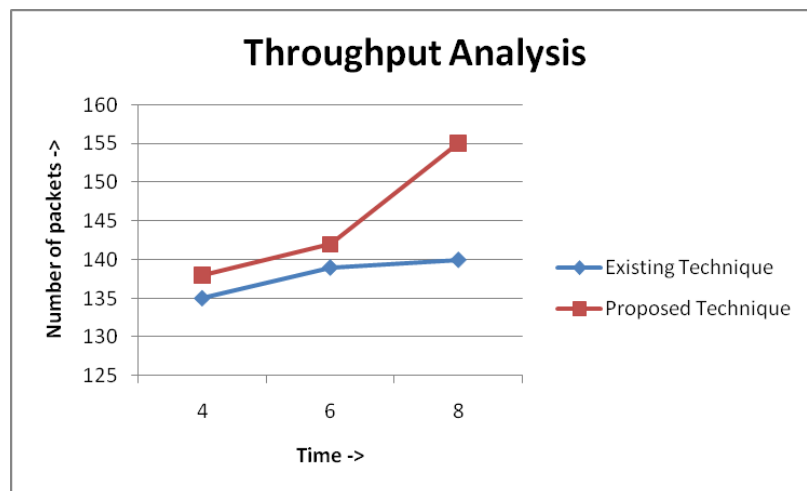


Figure 6. Throughput Comparison

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Figure 6 shows comparison of the existing and the new approach in terms of their throughput rate. The new approach gets better throughput rate than the earlier approach due to the implementation of the multicasting method.

5. Conclusion

In Vehicular Ad-hoc networks, wireless communication being an important technology helps to get multiple applications and services. Therefore, the mainly three categories in which routing algorithms can be divided. The broadcasting technique is used in the previous research work for the path establishment from source to destination. The broadcasting approach uses large amount of time and bandwidth for the data transmission. In this research work, the multicasting technique will be proposed for the data transmission which consume least bandwidth and transmit data in least amount of time. The results are analyzed in terms of certain parameters like Throughput, PDR and route lifetime. The proposed technique performs well in terms of all defined parameters. In future, the proposed algorithm can be improved with certain security parameters.

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