International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 2 (2018) pp. 823-829

Fault Tolerance Approach for Improving Connectivity in Vehicular Ad Hoc Network

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Abstract

Fault Tolerant in Vehicular Ad hoc Network environment is a positive step towards increasing the safety of the vehicles on road and it sets a trend of research in recent times. The real time information gathering and sharing between vehicles is a major step towards achieving the goals. In the proposed approach a fault tolerant scheme is implemented in which the road side stations monitor the faulty vehicles in the network. The design of the gateway fault tolerant approach ensures the connectivity between vehicles through road side stations and the request reply message flow in the network. The proposed approach is then compared with the basic on the basis of connection rate (for both 25% failure and without failure) and performs better as compared to basic approach. The proposed approach also considers the 25% fail rate of the vehicle nodes for average response time in the network and the results shows that the proposed approach performs better in case of failure also. The proposed approach outperforms the basic approach on the basis of average bandwidth usage per request and the success rate. The proposed approach will be implemented with other clustering approaches and overhead on the road side stations must be reduced and will be compared with the existing approaches.

Keyword: Vehicular Ad-hoc Network, Fault Tolerant, Clustering, Filtering.

INTRODUCTION

In several fields, the VANET has become significant area of research. It is found that VANET has capability to deal with variety of services like detecting nearest collisions and giving warning signals to aware driver. These all service is provided by VANET often based on association or among vehicles which are furnished with a relatively motion sensors and GPS units [1]. In VANETs, vehicles may communicate with road side units and with each other which permits access to back-end systems. This may give drivers with significant data and enable them to access various intelligent transportation systems. In most of applications of intelligent transportation system, the major goal is to assure the comfort of passenger and their road safety [2]. One of the major issues in these networks is gateway discovery that is required to give drivers as well as passengers with security, internet access and other services. Recently, many protocols in VANETs use the global positioning system (GPS) for assistance [3]. The coordinates of each node can be known by using GPS. Furthermore, the route discovery process can be completed by mathematically calculation to determine the routing path. Thus, the routing protocols can reduce the overhead amount effectively. Recently, most of the automobile have intra conveyance network that permits wireless communication between vehicle and electronic gadgets like good phone, Global Positioning System (GPS), Bluetooth media players. However the lay conveyance communication network continues to be not on the market. Therefore to produce lay conveyance communication VANET i.e. vehicular ad-hoc Network technologies arising. Vehicular unexpected networks (VANETs) are designed as a set of mobile unexpected networks with the distinctive property that the nodes here are vehicles [4]. So node i.e. vehicle movement is restricted by road course, encompassing traffic and traffic rules. The various challenges have been faced by Gateway discovery protocols in vehicular networks such as fault tolerance, high mobility and communication efficiency.

Gateway discovery protocols may be divided into three groups. These are as following:

Proactive approach:

In this approach, gateways broadcast advertisement messages periodically in the network. This proactive approach gives high overload and good connectivity; thus these provide limited scalability to the protocols

Reactive approach:

In this approach, gateway requesters request for the message until a suitable route is found. With the raise

In requesters, messages exchanged for the gateway discovery are also increased. Hence it can be said that, scalability is not assured unless a suitable propagation approach is used. in this category, some presented protocols are taken into consideration: context-aware discovery, limited time-to-live of REQMsgs and the use of the hash table in both geographical and distributed approaches [5].

Hybrid approach

This approach is the combination of reactive and proactive approaches. This occurs when gateways promote themselves, and requesters find out the services in a proactive way if they are inside the zone of the gateway. Or else, requests are spreads reactively until they reach the advertisement zone of the gateway. In this approach, the essential factor is how to determine the range and the frequency of the gateway advertisement.

RELATED WORK

Saha et al in [1] proposed novel method of node motion depending on the vehicle movements. This proposed model utilized with ns-2 network simulator. Comparison has been done among proposed method and Random Waypoint mobility model. The comparison result indicates that the Random Waypoint mobility model is better in some cases for vehicle motion on roads, but in some cases proposed model is better suited**.** In modern time [2], intelligent transport system are very significant, thus immense research work has been devoted to this field. Efficient vehicular approaches may increase security, decrease the traffic incidents and alleviate the impact of congestion. This paper aims to provide brief description of intelligent system on vehicular communication. In [3] presented an adaptive QoS based routing for VANETs network and termed as AQRV. this proposed protocol is adaptively selects the intersection from which data or information may pass to reach to its final destination. The route which is chosen must be satisfied with all the parameter of QoS and perform the QoS in terms of three constraints, delay, connectivity probability and packet delivery ratio. in order to solve the minor issue ACO based algorithm has also been proposed in this paper. the concept of terminal intersection has been proposed to reduce the time of routing exploration and also alleviate network congestion. additionally in this paper LQm (Local QoS model) has also been presented in order to determine the real time and fulfill the QoS of urban road segment.

Christian in [4] proposed a routing strategy for VANET in city environments has been presented In this paper, geographic source routing' (GSR) has been proposed, which combines position-based routing as a promising routing strategy for VANET in city environments. It is demonstrated by a simulations study that made use of realistic vehicular traffic in a city environment that GSR outperforms topology-based approaches like DSR and AODV with respect to delivery rate and latency vehicles. Third, we study approaches that do not need a navigational system but where 'local maps', particularly for junctions, are inferred from observing transmitted packets and vehicle movement patterns. In [5] nodes which are based on energy are improving the capability of AODV protocol. Location aided routing protocol decrease the possibility of finding the destination by maintaining the record of position of each node in the network with respect to other nodes. The main aim of this LAR protocol is to increase the energy developing in the network. In this scheme, the performance of normal AODV, AODV with LAR is described here and showing that the LAR protocol decreases the energy consumption and enhance the network lifetime that fully based on the energy of mobile nodes. The overhead route discovery [6] is reduced by developing location information of mobile nodes which can be obtained using GPS. It is popular and significant mechanism for decreasing control message overhead [7]. The simulation has been executed by using Glomosim 2.03 simulator. The result analysis indicated that the proposed model attains maximum packet delivery ratio i.e. 99.68 % and end to end delay is 7.3199 ms and delay for highly populated network is 0.01768 ms.

METHODOLOGY

Major concern of this work is to reduce the faults in the network. The faults may be due to node failure i.e. node not recognized in the network during route discovery or the direction of the selected node differs from the source node.

Clustering is performed and id of each vehicle in the cluster is sent to the road side station. The Cluster Head (CH) creates the TDMA time slot for each vehicle within the cluster. Two owners for each slot is assigned as the Original Owner (OW) and Alternate Owner (AW). If the OW has data to send, it sends the data otherwise send ‘No Data to Send’ to CH. After this CH will wait for the timeout period and send request to the AW.

If the vehicle does not receive the request message, then CH will wait for the contention timeslot announcement message and ready to register newer vehicles, as soon as it receives the request message from the new vehicle.

For establishing the connection between the nodes, a three-way handshaking protocol must be used and followed. Also the connection establishment consists of two phases, i.e. setup phase and steady state phase. In setup phase the connection between the two vehicles and the roadside station is established and in steady state phase the data is transferred. A fault occurs when the connection is established in setup phase, but the packets are lost in the steady state phase. For achieving the set target, we must follow the steps given below.

1) In establishing the connection all the vehicles who wants to transfer data, requests the CH for connection during the setup phase. At the end of the setup phase during contention time slot, the CH broadcasts the cluster node id in the cluster and their time slots in TDMA frame and stores a copy in the road side unit. Two owners for each time slot are maintained by the CH.
2) Now the CH requests each node to transfer the data to the CH, if the original owner of the time slot is not

responding for single request then the alternate owner must be requested.

Fault is occurred if the node is moved from the cluster then road side unit checks the list stored by other CH and search for that node. If the other list contains the id of the moved node, then the communication process continues otherwise the node is considered faulty.

Algorithm for Fault tolerant Scalable I-GPSR

```
Start
initialize n ← location, where n is the node    // Initialization of wireless nodes in the network
    for i = 0: N, where N is the total no. of nodes// Loop working for all the nodes
        R_i ← Range(n_i), Range of i^th node    // Range of the node (in NS-2 generally considered between 200 -400 m)
        Nu_1, Nu_2, Consider two random nodes in range with one another  // two random nodes and making them Cluster Head
    CalcV ← Velocity(n_i, Nu_1, Nu_2), Relative Velocity between vehicles // Relative Velocity between two random nodes and other vehicles (positive value considered)
        CalcA ← Acc(n_i, Nu_1, Nu_2), relative Acceleration    // Relative acceleration between two random nodes and other vehicles (positive value considered)
        CalcD ← Distance(n_i, Nu_1, Nu_2), Distance between vehicles and other neighboring nodes    // calculation of distance between the two nodes and the other nodes in the network
    if(CalcD_i, Nu_1 > CalcD_i, Nu_2)    // If a node is closer to the second node
            if(dirNu_2 = n_i, CalcV, CalcA)    // then the direction , relative velocity and relative acceleration is considered, direction must be same and other two must be positive
                Cluster(Nu_2) ← CalcD_i    // ith node must be included in the cluster of second node
        else    // else if a node is closer to the first node
            if(dirNu_1 = n_i, CalcV, CalcA)    // then the direction, relative velocity and relative acceleration must be considered, direction must be same and other two must be positive
                Cluster(Nu_1) ← CalcD_i    // ith node must be included in the cluster of node 1
    endfor    // end of the for loop
    for j 0: n_c, where n_c is number of clusters    // loop for all the clusters
        Info ← CH_info_j, Cluster Head broadcasts information    // CH collects the info from the nodes (both original owner and alternate owner
        RSS_initial ← Info, receives cluster information    // info is transferred to the road side station as initial info
    endfor    // end of the cluster for loop
    for j 0: n_c, where n_c is number of clusters    // loop for all the clusters
        fori = 0: n, where n is the number of nodes in cluster    // loop for number of nodes in a cluster
            if(Range_i ≥ CH_jdist)    // if a node lies in the range of CH
                Cluster(CH_j) ← n_i // must be included in the cluster of CH (setup phase)
endfor    // end of setup phase for loop
        fori = 0: n, where n is the number of nodes in cluster    // start of for loop for number of nodes in a cluster (steady state phase
    Cluster_info(j) ← Node_info, receives node information from Original Owner and Alternate Owner    // CH receives information from the nodes in the cluster from Original Owner as well as as Alternate Owner or whichever is applicable
   if(Range_i ≥ CH_jdist), for contention period    // Comparison of range again for small contention time period (for fault tolerance, so the packets must not be wasted)
                Cluster(CH_j) ← n_i // old node must be removed (which is not in range)  or new node must be added in this phase
        end for    // end of setup phase loop
      RSS ← Cluster_info(j), receives cluster information    // RSS receives cluster info from the CH
        if (RSS_initial == Empty)    // if RSS initial has no prior info
            RSS_initial ← RSS    // treat current info as the initial info
        else    //else directly compares the whole RSS info
        Compare(RSS_initial, RSS), Comparison of the lists    // Comparison of RSS info lists
        F ← Compare(RSS_initial, RSS)    // Faulty node if any must be the output of the function
        RSS_initial ← RSS    // makes the current info as the initial info and the process continues
        endfor    // end of for loop for cluster nodes
end    //
end of the program
```

Vehicles in the network are initialized with the wireless network parameters. Number of nodes in the network are considered to be n and the velocity, acceleration and the distance between the nodes is determined in the network. For clustering in the network two vehicles are considered in the network, which are in range with each other. The distance of the other nodes nodes from these two nodes is calculated and arranged in the cluster of the vehicle which is at less distance from the selected vehicle. The direction of the selected node must be same as that of the randomly selected node. The cluster head (initially randomly selected node is considered as the cluster head) then broadcasts the information of the nodes in the cluster to the road side station. For the fault detection the road side station in range of the cluster head will check the vehicle in corresponding clusters. If the vehicle is not found in the other cluster head table information, then the vehicle is considered as faulty.

RESULTS AND DISCUSSIONS

NS-2 is an event based simulator which runs on object oriented C++ at the backend. NS-2 uses OTCL as the frontend where various class objects of C++ are implemented and called. The simulator supports large number of protocols and an animator for the visual output of the network.The proposed methodology is implemented using the NS-2 Simulator with the following parameters shown in table 1. Simulation parameters must be set before the simulation of the environment. The important parameters are channel which is set to wireless channel as the network under consideration is wireless. The model used for the propagation of EM waves is set to be two ray ground. IEEE standard for the MAC, IEEE 802.11 is used for the media access control layer of each vehicle. Antenna must send or receive packets from all the directions so the C++ class of NS2.35, Omni Directional Antenna is used. Number of vehicles is set to be around 100 and simulation time is 300 s.

Table 1: Experimental Set up

Channel	Wireless Channel
Propagation Model	Two Ray Ground
Mac	IEEE 802.11
Antenna	Omni Directional Antenna
Number of Vehicles	~100
Simulation Time	300 s
Transmission Range	100 m
Maximum Gateway Coverage	250 m

The vehicular Ad hoc network is created and the proposed fault tolerant scheme is compared with the basic fault tolerant mechanism. Figure 1 shows the response time comparison of both the approaches. In the graph the basic FTLAGAD is taken at a failure rate of 25% and our proposed approach with the same failure rate. The response time increases when the number of faulty vehicles increases, as the failure of vehicle means that the packet is targeted through some longer route which increases the response time. Average response time is defined as

Average Response Time = Request Grant Time-Request Time

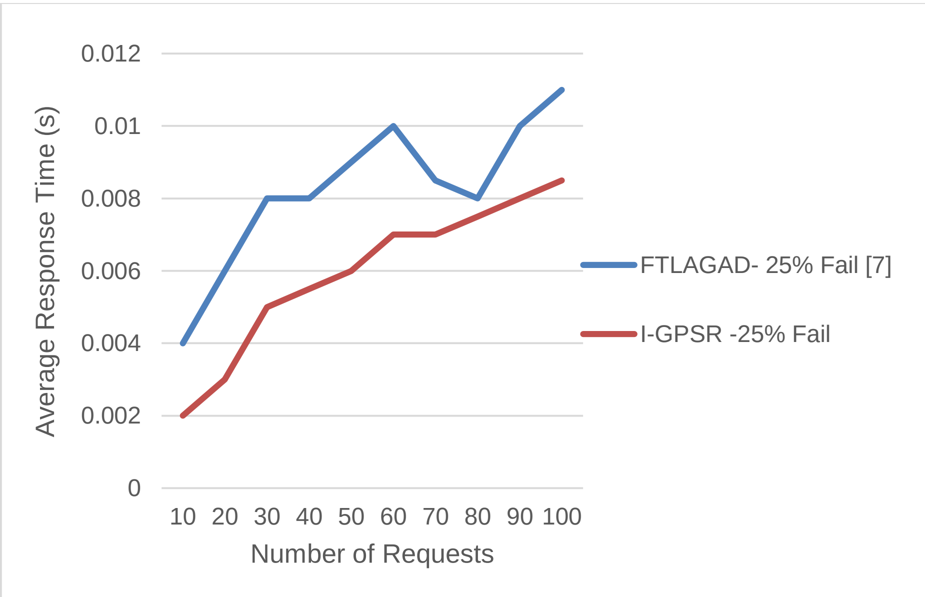

Figure 1: Average Response Time with 25% Failure of Vehicles

Figure 2 shows the connection rate which is improved as the fault tolerant mechanism is introduced and the packets are forced to follow the certain path through non faulty vehicles. Connection rate is defined as

$$Connection\ Rate = \frac{Successful\ Connections}{number\ of\ reuests}$$

Figure 3 shows the graph of the average bandwidth usage per request and the graph shows the average bandwidth usage between the proposed approach and the basic approach is comparable. This also ensures that the proposed approach maintains a reasonable usage of bandwidth throughout the request period.

Figure 4 shows the plot of success rate between the FT-LAGAD and the proposed approach and proposed approach maintains a good success rate as compared to the basic approach. This ensures that the gateway reply and request message scan be directed towards the destination with a fewer loss in packet

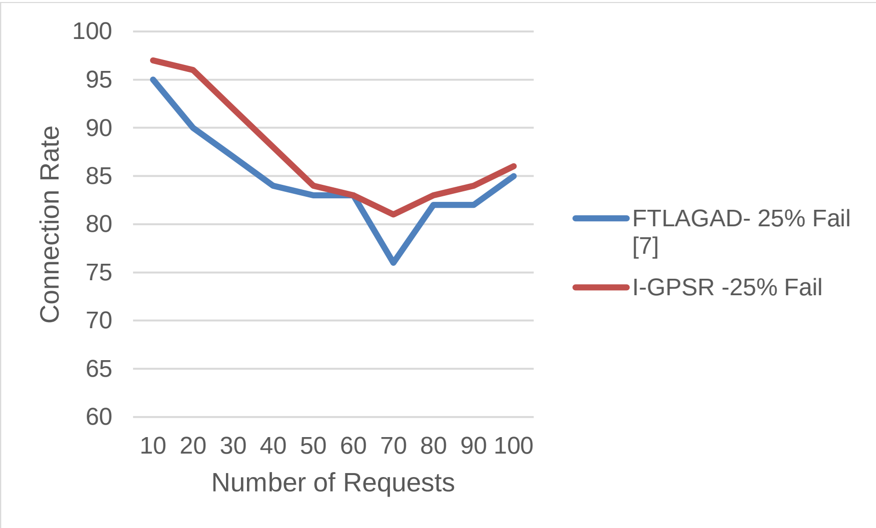

Figure 2: Connection Rate with 25% Failure of Vehicles

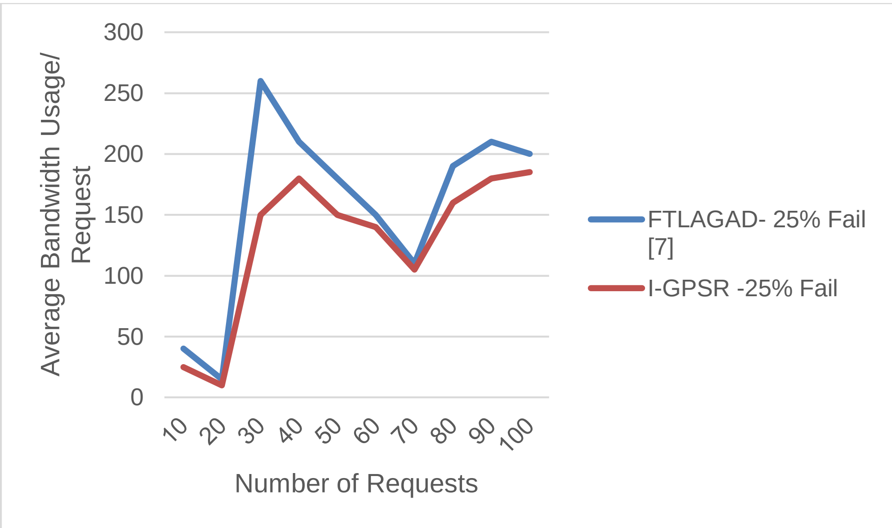

Figure 3: Average Bandwidth Usage per Request with 25% failure of Vehicles

Figure 4: Variation of Success rate with Number of nodes

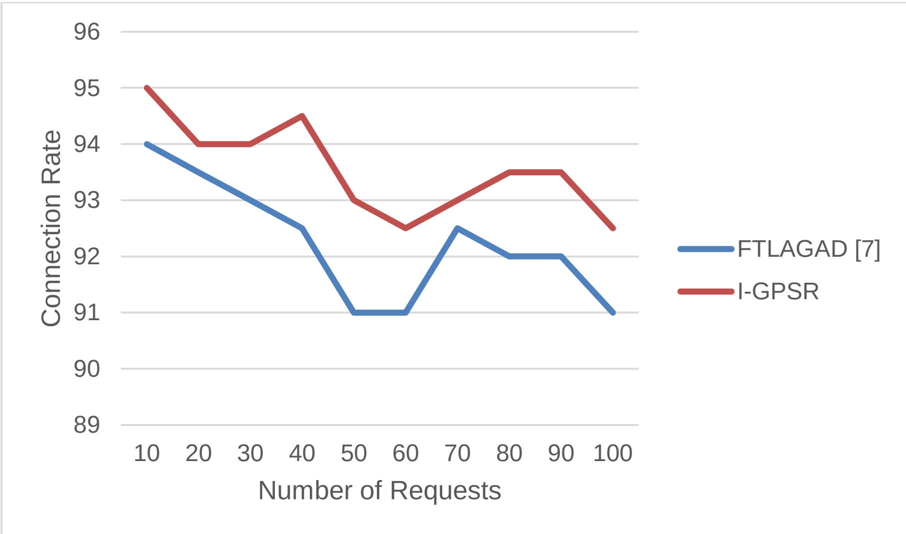

Figure 5: Variation of Connection Rate with Number of Nodes.

Figure 5 shows the graph of connection rate plotted for the requests ranging from 10 to 100. The proposed approach shows good connection rate as compared to the basic approach. As the number of requests increases in the network the connection rate is falling as the faulty vehicles in the road increases which deteriorates the path for the requests and reply messages. Success Rate is defined as

$$Success\ Rate = \frac{Successful\ Data\ Transactions}{Number\ of\ Requests}$$

CONCLUSION AND FUTURE WORK

Fault Tolerance in the vehicular Ad hoc Network is a widely researched area in the recent years. Many techniques like Location Aided Advertisement and Discovery Protocol (LAGAD) and Fault Tolerant (FT-LAGAD) which perform well in some environments. FT-LAGAD uses the next hop neighbors for the transfer of messages. In the proposed approach the road side unit take into account the number of vehicles in the range and maintains the list of the cluster of vehicles and monitors the fault in the network. The proposed approach is then compared with the FT-LAGAD and the results on the basis of various performance parameters shows that the proposed approach performs well in the similar environment. The performance parameters for the comparison are average response time, connection rate, success rate and average bandwidth usage. The proposed approach is also considered with 25% fail nodes for connection rate and the response time. The proposed approach performs better as compared to the FT-LAGAD approach in terms of the success rate and average bandwidth usage and others. In future other fault tolerant schemes must be implemented and compared with the existing approaches.

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