A Beacon-less Multi-channel Packet Forwarding Scheme in Vehicular Networks

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Abstract - The ad-hoc vehicular network is a sub stream of an ad-hoc mobile network where the nodes can converse and know each other by their periodic control packet dissemination. In vehicular network communication, the available bandwidth is limited. The parallel and multi-vehicle channel access will create an unwanted delay during the packet dissemination. The node may compete with each other to access the channel during parallel communication. The simultaneous channel access will increase network overload. The proposed approach will minimize the channel access collision through the variable time slots. Before any data dissemination, the node will send a Channel Booking Request (CBR) message to a correspondent node. The spectrum allocation is based on the type of vehicle and message code. The concept has experimented with traditional routing protocols for overtaking assistance. The proposed approach is compared with the packet delivery rate, jitter, and packet loss rate.

1. Introduction
The vehicular nodes can able to communicate with their peer node directly without any fixed infrastructure. Due to [1] the nature of dynamic and fast-changing network topology, the control packet dissemination will not be effective as compared to the ad-hoc [2] mobile environment. The mobility of the ad-hoc mobile network of nodes is quite less compared to the ad-hoc vehicular node. The unwanted duplicate hello message distribution leads the network into congestion. Any time channel access may degrade the performance in terms of resource allocation and utilization. [3] The proactive routing protocols are sufficient for short term communication. For long term communication, the node will depend on the neighbor vehicle to disseminate the message to [4] the target vehicle. In a vehicular environment, frequent topology change will happen which may lead the network into packet transmission failure. Also, [5] the traffic density depends on the road environment like highway or urban. The traditional mobile networks will follow the route request-response model for packet transmission. The geographic position-based routing approach does not maintain the route between the source and destination. In geographic routing, the packet transmission depends on the neighbor vehicle cooperation. The neighbor [6] node information is obtained through the periodic control packet dissemination. The vehicle should enable the GPS to obtain the current location updates. The location-based forwarding algorithms will maintain one-hop peer vehicle information through mutual collaboration among peers. [7] The location-based forwarding scheme looks for the optimal relay from the routing table. The route selection should depend on the stability among the neighbors. Figure 1 shows the vehicular network communication scenario.

Fig. 1: Ad-hoc Vehicular Communication

2. Literature survey
In [8] investigated decentralized detection in ad-hoc vehicular networks. The system experiments the clustering to group the equal behavior nodes. A node called ‘captain’ will act as a mentor for all other nodes. The cluster group does not have an equal configuration. [9] investigated the intrusion detection methodology to safeguard the node from the attacks like Sybil, illusion, and false position attack. [10] proposed and investigated the distributed road-casting protocol to transmit safety messages in an urban environment. [11] discussed the heterogeneous movement prediction approach for reliable data dissemination. The vehicle will consider the current position, location, and speed of the vehicle for reliability prediction. [12] investigated the comfort zone prediction during the overtaking by predicting the cooperative assistance. The system implies two-way traffic during the simulation. [13] discussed the hello packet dissemination to know the neighbors. The neighbor vehicle will know the neighbor node entries through the periodic transmission of the vehicle speed, location. [14] investigated the IEEE 802.11 p standard for ad-hoc vehicular networks. The spectrum allocated for the service and control channel is defined from the range 5.850 GHz-5.925 GHz. [15] discussed the position-based GPSR routing protocol. The current vehicle will choose the relay that is farthest away from the source vehicle. In GPSR the number of the intermediate relay will be minimized. [16] reviewed the route cause for vehicle accidents. The survey says that greater than 70 percent of the accidents are due to over speed and unpredictable overtaking. [17] investigated the traffic re-routing by the genetic algorithm. The experiment

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exploits the characteristics of the vehicular environment to predict alternative routing. [18] investigated FMBA which selects a single forwarder with diverge contention window size. The most optimal forwarder will be taken to relay the packets to the destination.

3. Problem formulation
In this work are proposing a beacon-free cluster-based driver [19] assistance System in ad-hoc vehicular networks for sending warning messages to the right destination vehicle. In our approach, the RSU will elect the cluster head [20] for the first time. Whenever the election process is completed, the leader vehicle is responsible for sending any messages among the vehicles with their cluster. The cluster head acts as a leader, whenever the node (vehicles) moves from one RSU to another RSU. The cluster head itself elects the CH and leave. For electing the cluster head, we [21] are considering fitness factor parameters like less mobility, high energy, high connectivity, etc. Our proposed scheme focused on selecting the right destination for sending warning messages.

4. Proposed model
Persistent beacon-less multiple accesses
The channel access is based on the type of message_code. The node waiting time and the message_code will be considered for channel access. The system will use a time division multiple access schemes while competing. Figure 2 shows the multi-channel slot reservation. Figure 3 shows the process flow of the beacon-less channel access. Table 1 Spectrum Distribution for Service and Control Channel.

| Parameters | Spectrum Range       | Bandwidth |
|------------|----------------------|-----------|
| Spectrum   | 5.850 GHZ-5.925 GHZ  | 75MHZ     |
| Data rate  | 5-27Mbps             | -         |
| Coverage   | 400 Meters           | -         |
| Reserved   | 5.850 GHZ -5.855 GHZ | 5MHZ      |
| SCH        | 5.855 GHZ -5.865 GHZ |          |
| SCH        | 5.865 GHZ -5.875 GHZ |          |
| CCH        | 5.885 GHZ -5.895 GHZ | 10MHZ     |
| SCH        | 5.895 GHZ -5.905 GHZ |          |
| SCH        | 5.905 GHZ -5.915 GHZ |          |
| SCH        | 5.915GHZ -5.925 GHZ  |          |

Network Formation
In our proposed approach first, the Roadside Unit (RSU) will split the road segment into zones. We assume that the coverage of RSU is 1 kilometer wide. The RSU maintains the [22] database like a vehicle and its direction. The direction of the zones z1, z2, z3, z4, z5 should be from left to right. The direction of the zones z6, z7, z8, z9, z10 should be from right to left. Each zone is 200 meters wide.

Steps for Secure Routing
Secure cluster selection
In Secure Cluster Selection, it includes the process of selecting a cluster. In our work, the cluster selection is combined with the anonymous [23] method. So, it is carried out with the process of anonymous cluster selection. As it is an anonymous process, it enhances security.
Secure source selection
In secure source selection, security source selection is combined with anonymous and trust methods. These nodes in a cluster have respective trust values and the CH selects an anonymous node [24] with a greater trust value and that node is taken as a source.

Transmission and Acknowledgement
This part encompasses the transmission process which includes the request and reply process. It includes two types a) cluster req (CRQ) and rep (CRP), route req (RRQ), and rep (RRP). In this, the above two types are used to strengthen the safe process.

Secure destination selection
In secure destination selection, security destination selection is combined with anonymous and trust methods. In these nodes in a cluster has respective trust values and the CH selects an anonymous node with a greater trust value and that node is taken as the destination.

Initial Cluster Head Election
Whenever RSU is ready to provide service, it will store the information about the vehicles in the database. The Roadside unit will send the cluster formation message to the first entered vehicle. The RSU tells the leader to update neighbor information’s like speed, direction, zones area through the Utility function. Now, that node is acting as cluster head and CH will send the cluster to join message to its neighbor vehicles. Each vehicle may aware of its neighbors by sending hello messages. The cluster head is responsible for sending messages to each other as shown in Figure 5.

Anonymous cluster routing protocol is used in this method. Each cluster has its cluster values and trust values and each node in that particular cluster has its trusted-sub values. So, based on that trusted-sub values, the CH is selected and that furthermore selects the trusted source and sink nodes for packet transfer. Once the source node is selected the TCRQQ (request) is sent and waits for the TCRRP (reply). After the data packets are been received by the sink node it sends the acknowledgment. From the source node, it waits for the particular time duration (default) and if the acknowledgment is not received then it resends the message once again and if it happens again then it aborts the transmission process for a while. This reduces the energy consumption of a node and fastens the process.

Cluster Head Shifting
Whenever the cluster head is moving from one RSU to another RSU, the cluster head itself electing the suitable next cluster head with their next fitness factor and also the information regard the vehicle is also passed to those vehicles. The nodes can reuse the same information without further processing. Figure 7 shows the Cluster formation procedure.

Fig. 5: Initial Cluster Head Selection

Anonymity is the state of being unknown or not revealing its identity. Anonymity plays an important role in the process of security. The information is sent as the data packets or packets between the two nodes. In this process or method firstly, the data packets that consist of a secret message are encrypted and sent and when it reaches each trusted node with greater trust value furthermore encryption is added. With this process, a public key and a cluster key is added. The cluster key is automatically generated key with the group trust value. In addition to this group, a signature is also used. So finally, when it reaches the sink node there are more layers in the received packet. The sink node which is been verified by the CH then decrypts with the respective group signature and key. This process is used for authentication and implements a double layer of protection so that the intermediate nodes without trust sub-values and cluster values cannot open the message or form the route.

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Fig. 6: Proposed Approach Process Flow

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Fig 7: Cluster formation procedure
The cluster head doesn’t want to calculate the befit factor, utilization function for the active vehicles. Now the newly elected cluster head acts as a leader for their cluster for further data transmission. Figure 8 shows the Cluster Head Leaving.

**Vehicle overtaking**

The Roadside Unit (RSU) will maintain a dedicated direction aware database. The zones z1, z2, z3, z4, z5 follows the direction left to right. Similarly, the zones z6, z7, z8, z9, z10 follows the direction right to left. Whenever the vehicle is trying to overtake vehicle changes its zone from Z2 to Z8. Now cluster head identifies that the vehicle is entered into Z8 but their right direction is right to left. Now cluster head knows that the problem with the direction, so the CH will send the warning messages to the vehicle V7. Now the vehicle V7 make some decision about their control. Figure 9 shows the Action against overtaking.

Among different vehicles, cluster heads need to find the right destination for sending warning messages. In this regard, the zone front end and the rear end starting point is initially given by RSU to the zone leader. Now the Cluster head checks each node's current location by the Global Positioning System (GPS) which compares the overtaken vehicle v7 with all other nodes (v8, v4, v6, v5). This way we can find the right destination for warning message passing. Figure 10 shows the Action against overtaking.

5. Results and discussion

The proposed work is simulated in ns2. Our simulation work compares the performances of beacon-less DSR, AODV, and DSDV for warning message sending. The protocol AODV and DSR will give better performance in terms of packet delivery ratio, end-to-end delay, packet loss, jitter, etc. For generating mobility for Vehicular Environment, we are using Vanetmobisim 1.1 in network simulator 2. The simulation experimented in 2000*2000 coverage area. The system uses the car-following model to ensure safe minimum clearance. The system takes 1024 bytes of data for packet forwarding which takes the traffic type as constant bit rate as 1 per 0.05 second.

| Simulator | NS2.34 |
|------------|--------|
| Simulation area | 2 kilometers |
| MAC protocol | IEEE 802.11P |
| Vehicle mobility model | Car following model |
| Vehicle speed | 50-120km/hr |
| Transmission range | 200-350m |
| Number of lanes | 2 |
| Packet size | 1024 bytes |
| Number of vehicles | 40 |
| Traffic type | CBR |
| Beacon interval | 0.2 sec |
| Packet interval | 0.05 sec |
| Average number of Simulations | 50 |
| Highway simulation time | 150sec |
Table 2 shows Simulation parameters and Figure 11 shows VanetMobiSim Road scenario

**Table 3: Packet delivery ratio**

|                  | 10 nodes | 20 nodes | 30 nodes | 40 nodes |
|------------------|----------|----------|----------|----------|
| **AODV**         | 93.2056  | 99.325   | 99.12    | 99.499   |
| **DSR**          | 90.4345  | 100      | 99.71    | 100      |
| **DSDV**         | 44.64    | 49.867   | 67.2163  | 81.2277  |

**Figure 12:** Packet delivery ratio Vs. Number of nodes

Table 3 shows Packet delivery ratio Vs. Number of nodes.

**Table 4: Jitter Vs. Number of Nodes**

|      | 10 nodes | 20 nodes | 30 nodes | 40 nodes |
|------|----------|----------|----------|----------|
| **AODV** | 0.18227  | 0.13252  | 0.09588  | 0.07012  |
| **DSR**  | 0.18755  | 0.13183  | 0.0949   | 0.0701   |
| **DSDV** | 0.38451  | 0.23501  | 0.12699  | 0.08108  |

**Figure 13:** Jitter Vs. Number of Nodes

Table 4 and Figure 13 shows Jitter Vs. Number of Nodes.

**Table 5: Packet Loss Vs. Number of Nodes**

|      | 10 nodes | 20 nodes | 30 nodes | 40 nodes |
|------|----------|----------|----------|----------|
| **AODV** | 39       | 5        | 9        | 7        |
| **DSR**  | 55       | 0        | 3        | 0        |
| **DSDV** | 315      | 377      | 338      | 263      |

**Figure 14:** Packet Loss Vs. Number of Nodes

Table 5 and Figure 14 shows Packet Loss Vs. Number of Nodes.

6. **Conclusion**

The objective of the work is to minimize the hello packet transmission during the neighbor node discovery and to transmit the emergency messages to the target vehicle. Thus, the system can provide secure trusted data transfer and reduces packet delay and time consumption. Based on the information passed by a cluster head can take remedial action while driving. The simulation results compare the performance of the different routing protocols for better packet delivery. The system will take a minimum number of hello packets for the neighbor node discovery. The proposed system will give better performance in terms of packet delivery success rate, jitter and packet loss ratio in the traditional routing protocols.
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